PB-20G AUTOPILOT TROUBLE SHOOTING CHART

MAKE TESTS OR REPLACE COMPONENTS IN THE ORDER INDICATED

ABBREVIATIONS

A/C—ALTITUDE CONTROL
A/P—AUTOPILOT
CPS—CYCLES PER SECOND
PSH—PRESET HEADING

FLIGHT REPORT	AXIS: ELEVATOR	AXIS: AILERON	AXIS: RUDDER	PART REPLACEMENT: RATE GYRO	VERTICAL GYRO	AIR DATA SENSOR	AMPLIFIER-COMPUTER	CONTROL PANEL	POSITION TRANSMITTER	COMPASS SYSTEM	POWER JUNCTION BOX	LOC-VOR OR GS RECEIVER	TRIM SERVO	SURFACE SERVO	TILT VERT GYRO & NOTE RESPONSE	CHANGE HEADING & NOTE RESPONSE	ENGAGE A/P, TRY TO START OSCILL.	MOVE RATE GYRO & NOTE RESPONSE	PERFORM SYSTEM INTERLOCK TEST	SIMULATE CHANGE IN ALT-A/P ENGAGED	CHECK POS. TRANSM. NULL—50 MV	CHECK RATE GYRO NULL—40 MV	CHECK UP ELEV SIGNAL—10V MIN	CHECK VERTICAL GYRO NULL—50 MV	CHECK TRIM SERVO OPERATION	CHECK RADIO RECEIVER OUTPUT	CHECK COMPASS COUPLER OUTPUT	CHECK TURN OR PITCH CONTROL NULL—50 MV	CHECK AIR DATA SENSOR OUTPUT	CHECK ASSOCIATED SHIP'S WIRING	CHECK ADAPTER POT. SETTINGS	CHECK ALL NULLS IN SIGNAL CHAIN	CHECK SYNCHRONIZER OPERATION	CHECK SERVO FOLLOW-UP	CHECK SERVO RATE GENERATOR	BLOW OUT AND CHECK LINES TO A.D.S	CHECK SERVO CLUTCH OPERATION	CHECK FLAP POSITION SWITCH	CHECK RUDDER ENGAGE RELAY	CHECK WHEEL DISENGAGE SWITCH	CHECK WARNING LIGHT FLASHER	CHECK WARNING LIGHT RELAY	CHECK EMERGENCY 28V DC BUS	CHECK FRICTION LEVEL	CHECK CABLE TENSION	FLIGHT REPORT
30. ALTITUDE HOLD SWITCH DOES NOT DISENGAGE WHEN GLIDE SLOPE ENGAGES.	■						2	3											1																											30
31. GLIDE SLOPE DOES NOT ENGAGE AT INTERCEPT.	■						2					3														1																				31
32. A/P ENGAGES IN A/P BUT NOT IN DAMPER MODE.	■	■	■				3	4											1		1									2																32
33. A/P DOES NOT HOLD IN GS AUTO MODE.	■						3	5				4							2							1																				33
34. A/P DOES NOT HOLD IN GS MAN MODE.	■						3	5				4							2							1																				34
35. WARNING LIGHT DOES NOT FLASH WHEN A/P DISENGAGES.							4																							2											3		1			35
36. WARNING LIGHT ON STEADY WHEN A/P DISENGAGES.																																									2		1			36
37. STABILIZER OUT OF TRIM, LIGHT OUT.	■						2																																				1			37

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Autopilot Trouble Shooting Chart
Figure 105 (Sheet 8 of 8)

PB-20G AUTOPILOT TROUBLE SHOOTING CHART

MAKE TESTS OR REPLACE COMPONENTS IN THE ORDER INDICATED

ABBREVIATIONS

A/C—ALTITUDE CONTROL
A/P—AUTOPILOT
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FLIGHT REPORT	AXIS: ELEVATOR	AXIS: AILERON	AXIS: RUDDER	PART REPLACEMENT: RATE GYRO	VERTICAL GYRO	AIR DATA SENSOR	AMPLIFIER-COMPUTER	CONTROL PANEL	POSITION TRANSMITTER	COMPASS SYSTEM	POWER JUNCTION BOX	LOC-VOR OR GS RECEIVER	TRIM SERVO	SURFACE SERVO	TILT VERT GYRO & NOTE RESPONSE	CHANGE HEADING & NOTE RESPONSE	ENGAGE A/P, TRY TO START OSCILL.	MOVE RATE GYRO & NOTE RESPONSE	PERFORM SYSTEM INTERLOCK TEST	SIMULATE CHANGE IN ALT.-A/P ENGAGED	CHECK POS. TRANSM. NULL—50 MV	CHECK RATE GYRO NULL—40 MV	CHECK UP ELEV SIGNAL—10V MIN	CHECK VERTICAL GYRO NULL—50 MV	CHECK TRIM SERVO OPERATION	CHECK RADIO RECEIVER OUTPUT	CHECK COMPASS COUPLER OUTPUT	CHECK TURN OR PITCH CONTROL NULL—50 MV	CHECK AIR DATA SENSOR OUTPUT	CHECK ASSOCIATED SHIP'S WIRING	CHECK ADAPTER POT. SETTINGS	CHECK ALL NULLS IN SIGNAL CHAIN	CHECK SYNCHRONIZER OPERATION	CHECK SERVO FOLLOW-UP	CHECK SERVO RATE GENERATOR	BLOW OUT AND CHECK LINES TO A. D. S	CHECK SERVO CLUTCH OPERATION	CHECK FLAP POSITION SWITCH	CHECK RUDDER ENGAGE RELAY	CHECK WHEEL DISENGAGE SWITCH	CHECK WARNING LIGHT FLASHER	CHECK WARNING LIGHT RELAY	CHECK EMERGENCY 28V DC BUS	CHECK FRICTION LEVEL	CHECK CABLE TENSION	FLIGHT REPORT
18. PITCH UP OR DOWN WHEN A/P DISENGAGED.																																														
	■						2						3												1																			4	5	18
19. A/P OVERCONTROLS OR IS OVER-SENSITIVE.	■			7	6		8	9						10	5			1										4			2			3										11		19
		■		7	6		8	9						10	5			1										4			2			3										11		
			■	4			5							6				1													2			3										7		
20. TURN CONTROL WILL NOT MAKE CORRECT TURN.	■				6		5							7	2								1								3			4												20
		■			8		5	6		7					3	4											2	1																		
			■	5			4									3															1			2												
21. A/P WILL NOT DISENGAGE.	■	■	■		4		3	5											1											2																21
22. A/P DISENGAGES BY ITSELF.	■	■	■		6		4	5			3								1											2																22
23. A/P WILL NOT ENGAGE.	■	■	■		6		4	5			3								1											2																23
24. A/P WILL NOT HOLD ALTITUDE, A/C ON.	■					4	3	5																					1							2								6		24
25. A/P WILL NOT HOLD PSH.		■					4	6		5						2											1		3																	25
26. A/P WILL NOT TRACK VOR.		■				8	5			7		6														1	2		3							4								9		26
27. A/P WILL NOT TRACK LOCALIZER		■	■			8	5			7		6														1	2		3							4								9		27
28. A/P WILL NOT TRACK GLIDE SLOPE.	■					6	4					5														1			2							3										28
29. OSCILLATIONS OF INCREASING MAGNITUDE.	■		■	4	6		5								3			2				1																								29
		■		6	7		5		4						3						1	2																								

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PB-20G AUTOPILOT TROUBLE SHOOTING CHART

MAKE TESTS OR REPLACE COMPONENTS IN THE ORDER INDICATED

ABBREVIATIONS

A/C—ALTITUDE CONTROL
A/P—AUTOPILOT
CPS—CYCLES PER SECOND
PSH—PRESET HEADING

AXIS: ELEVATOR, AILERON, RUDDER

PART REPLACEMENT: RATE GYRO through SURFACE SERVO

FLIGHT REPORT	ELEVATOR	AILERON	RUDDER	RATE GYRO	VERTICAL GYRO	AIR DATA SENSOR	AMPLIFIER-COMPUTER	CONTROL PANEL	POSITION TRANSMITTER	COMPASS SYSTEM	POWER JUNCTION BOX	LOC-VOR OR GS RECEIVER	TRIM SERVO	SURFACE SERVO	TILT VERT GYRO & NOTE RESPONSE	CHANGE HEADING & NOTE RESPONSE	ENGAGE A/P, TRY TO START OSCILL.	MOVE RATE GYRO & NOTE RESPONSE	PERFORM SYSTEM INTERLOCK TEST	SIMULATE CHANGE IN ALT-A/P ENGAGED	CHECK POS. TRANSM. NULL—50 MV	CHECK RATE GYRO NULL—40 MV	CHECK UP ELEV SIGNAL—10V MIN	CHECK VERTICAL GYRO NULL—50 MV	CHECK TRIM SERVO OPERATION	CHECK RADIO RECEIVER OUTPUT	CHECK COMPASS COUPLER OUTPUT	CHECK TURN OR PITCH CONTROL NULL—50 MV	CHECK AIR DATA SENSOR OUTPUT	CHECK ASSOCIATED SHIP'S WIRING	CHECK ADAPTER POT. SETTINGS	CHECK ALL NULLS IN SIGNAL CHAIN	CHECK SYNCHRONIZER OPERATION	CHECK SERVO FOLLOW-UP	CHECK SERVO RATE GENERATOR	BLOW OUT AND CHECK LINES TO A.D.S	CHECK SERVO CLUTCH OPERATION	CHECK FLAP POSITION SWITCH	CHECK RUDDER ENGAGE RELAY	CHECK WHEEL DISENGAGE SWITCH	CHECK WARNING LIGHT FLASHER	CHECK WARNING LIGHT RELAY	CHECK EMERGENCY 28V DC BUS	CHECK FRICTION LEVEL	CHECK CABLE TENSION	FLIGHT REPORT
9. TRIM SERVO CRANKS IN INCORRECT TRIM.	■						2						3												1																					9
10. AIRPLANE OSCILLATES BUT WILL DAMP OUT.	■		■	4			6										1	2				3									5													7	8	10
		■		4			6										1	2				3									5													7	8	
11. SUSTAINED OSCILLATIONS—FREQUENCY MUCH LOWER THAN ONE CPS.	■		■				5							6			4													3	2			1												11
		■					5		6	8				9			4										7			3	2			1												
12. SUSTAINED OSCILLATIONS—FREQUENCY ABOUT ONE CPS.	■		■				4							5			3													2					1											12
		■					4		5	7				8			3										6			2					1											
13. SUSTAINED OSCILLATIONS—FREQUENCY MUCH HIGHER THAN ONE CPS.	■	■	■				3							4																2					1											13
14. OSCILLATIONS OR PORPOISING ONLY WITH A/C ON.	■					4	3																						1							2								5	6	14
15. TRIM INDICATOR NOT ALIGNED, A/P ON AND AIRPLANE IN TRIM.	■	■	■				1																																							15
16. TRIM INDICATOR NOT ALIGNED BEFORE A/P ENGAGEMENT.	■				4		2	3		5				7																6		1														16
		■			6		3	5	7	4				6																8		2	1													
			■		4		2							3																5		1														
17. TRIM WARNING LIGHT STAYS ON.	■						2						3												1					4														5		17

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Autopilot Trouble Shooting Chart
Figure 105 (Sheet 6 of 8)

PB-20G AUTOPILOT TROUBLE SHOOTING CHART

MAKE TESTS OR REPLACE COMPONENTS IN THE ORDER INDICATED

ABBREVIATIONS

A/C—ALTITUDE CONTROL
A/P—AUTOPILOT
CPS—CYCLES PER SECOND
PSH—PRESET HEADING

FLIGHT REPORT	ELEVATOR	AILERON	RUDDER	RATE GYRO	VERTICAL GYRO	AIR DATA SENSOR	AMPLIFIER-COMPUTER	CONTROL PANEL	POSITION TRANSMITTER	COMPASS SYSTEM	POWER JUNCTION BOX	LOC-VOR OR GS RECEIVER	TRIM SERVO	SURFACE SERVO
1. "BUMP" UPON ENGAGEMENT OF AUTOPILOT—TRIM INDICATOR ALIGNED BEFORE ENGAGEMENT.	■							4					5	6
		■						4		5				6
			■											2
2. "BUMP" UPON ENGAGEMENT OF A/P—TRIM INDICATOR NOT ALIGNED BEFORE ENGAGEMENT.	■			5	4		2	3						6
		■			6		3	5	7	4				8
			■	3			2							4
3. INTERMITTENT MANEUVERS OR OCCASIONAL TRANSIENTS.	■				4		3						6	5
		■		7	6		5			8				9
			■				2							3
4. SUSTAINED CLIMB OR DIVE, A/C ON.	■					4	5							
5. SUSTAINED CLIMB OR DIVE, A/C OFF.	■				4		3							
6. A/P WILL NOT HOLD HEADING USING EITHER COMPASS SYSTEM, PSH AND VOR OFF.		■					3	4		5				
7. A/P WILL NOT HOLD HEADING. USING OTHER COMPASS SYSTEM CORRECTS TROUBLE. PSH & VOR OFF.		■								2				
8. ONE WING DOWN, HOLDING HEADING.			■	8			7		9					

FLIGHT REPORT	TILT VERT GYRO & NOTE RESPONSE	CHANGE HEADING & NOTE RESPONSE	ENGAGE A/P, TRY TO START OSCILL.	MOVE RATE GYRO & NOTE RESPONSE	PERFORM SYSTEM INTERLOCK TESTS	SIMULATE CHANGE IN ALT-A/P ENGAGED	CHECK POS. TRANSM. NULL—50 MV	CHECK RATE GYRO NULL—40 MV	CHECK UP ELEV SIGNAL—10V MIN	CHECK VERTICAL GYRO NULL—50 MV	CHECK TRIM SERVO OPERATION	CHECK RADIO RECEIVER OUTPUT	CHECK COMPASS COUPLER OUTPUT	CHECK TURN OR PITCH CONTROL NULL—50 MV	CHECK AIR DATA SENSOR OUTPUT	CHECK ASSOCIATED SHIP'S WIRING	CHECK ADAPTER POT. SETTINGS	CHECK ALL NULLS IN SIGNAL CHAIN	CHECK SYNCHRONIZER OPERATION	CHECK SERVO FOLLOW-UP	CHECK SERVO RATE GENERATOR	BLOW OUT AND CHECK LINES TO A.D.S	CHECK SERVO CLUTCH OPERATION	CHECK FLAP POSITION SWITCH	CHECK RUDDER ENGAGE SWITCH	CHECK WHEEL DISENGAGE RELAY	CHECK WARNING LIGHT FLASHER	CHECK WARNING LIGHT RELAY	CHECK EMERGENCY 28V DC BUS	CHECK FRICTION LEVEL	CHECK CABLE TENSION	FLIGHT REPORT
1. "BUMP" UPON ENGAGEMENT OF AUTOPILOT—TRIM INDICATOR ALIGNED BEFORE ENGAGEMENT.											2			3									1									1
													3	2									1									
																							1									
2. "BUMP" UPON ENGAGEMENT OF A/P—TRIM INDICATOR NOT ALIGNED BEFORE ENGAGEMENT.																		1														2
																		2	1													
																		1														
3. INTERMITTENT MANEUVERS OR OCCASIONAL TRANSIENTS.	2															7							1									3
	2			3									4										1									
																4							1									
4. SUSTAINED CLIMB OR DIVE, A/C ON.						1									2							3										4
5. SUSTAINED CLIMB OR DIVE, A/C OFF.	2									1																						5
6. A/P WILL NOT HOLD HEADING USING EITHER COMPASS SYSTEM, PSH AND VOR OFF.		2											1																			6
7. A/P WILL NOT HOLD HEADING. USING OTHER COMPASS SYSTEM CORRECTS TROUBLE. PSH & VOR OFF.													1																			7
8. ONE WING DOWN, HOLDING HEADING.	4			3			5	6										2	1											10		8

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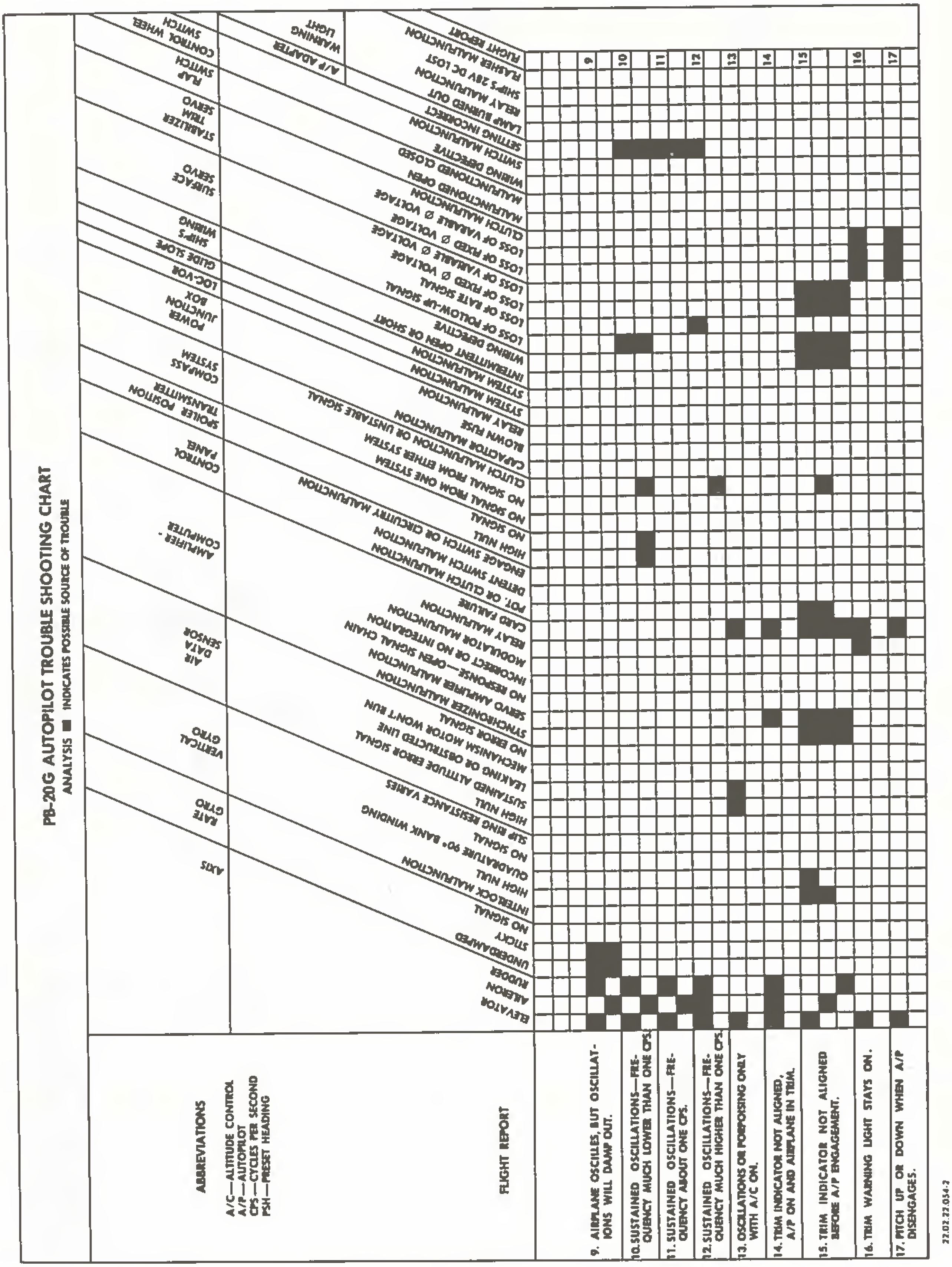
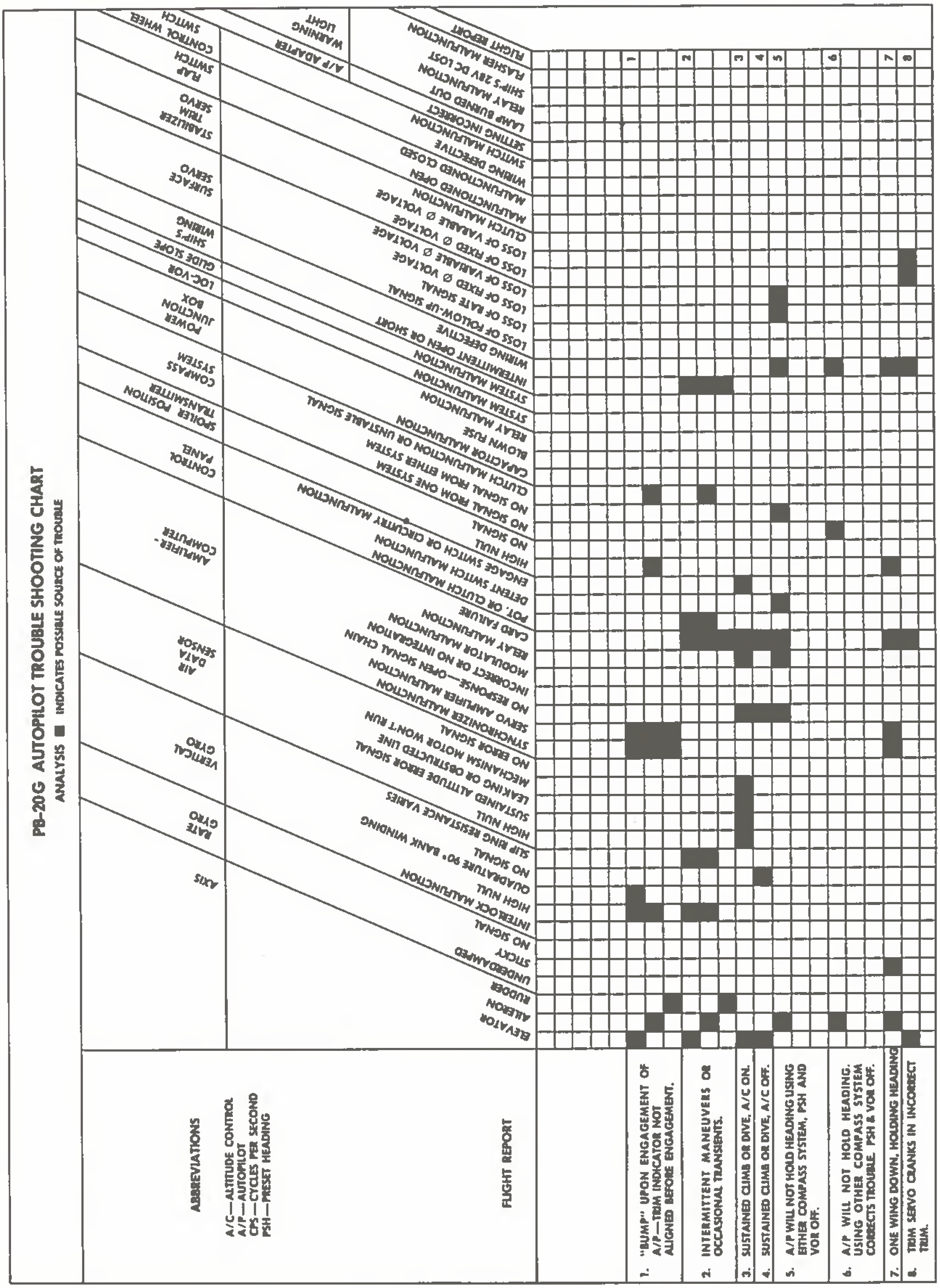
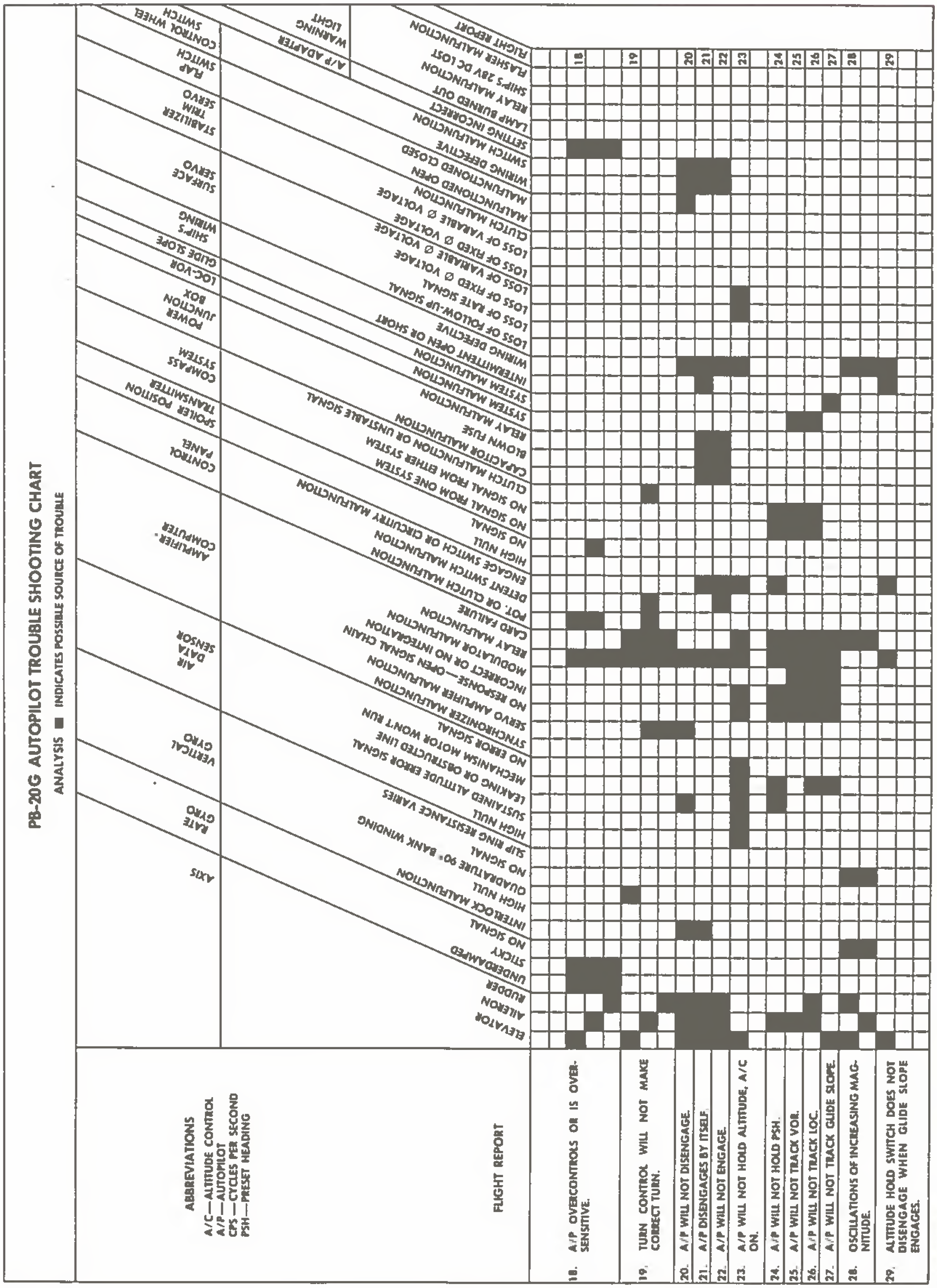


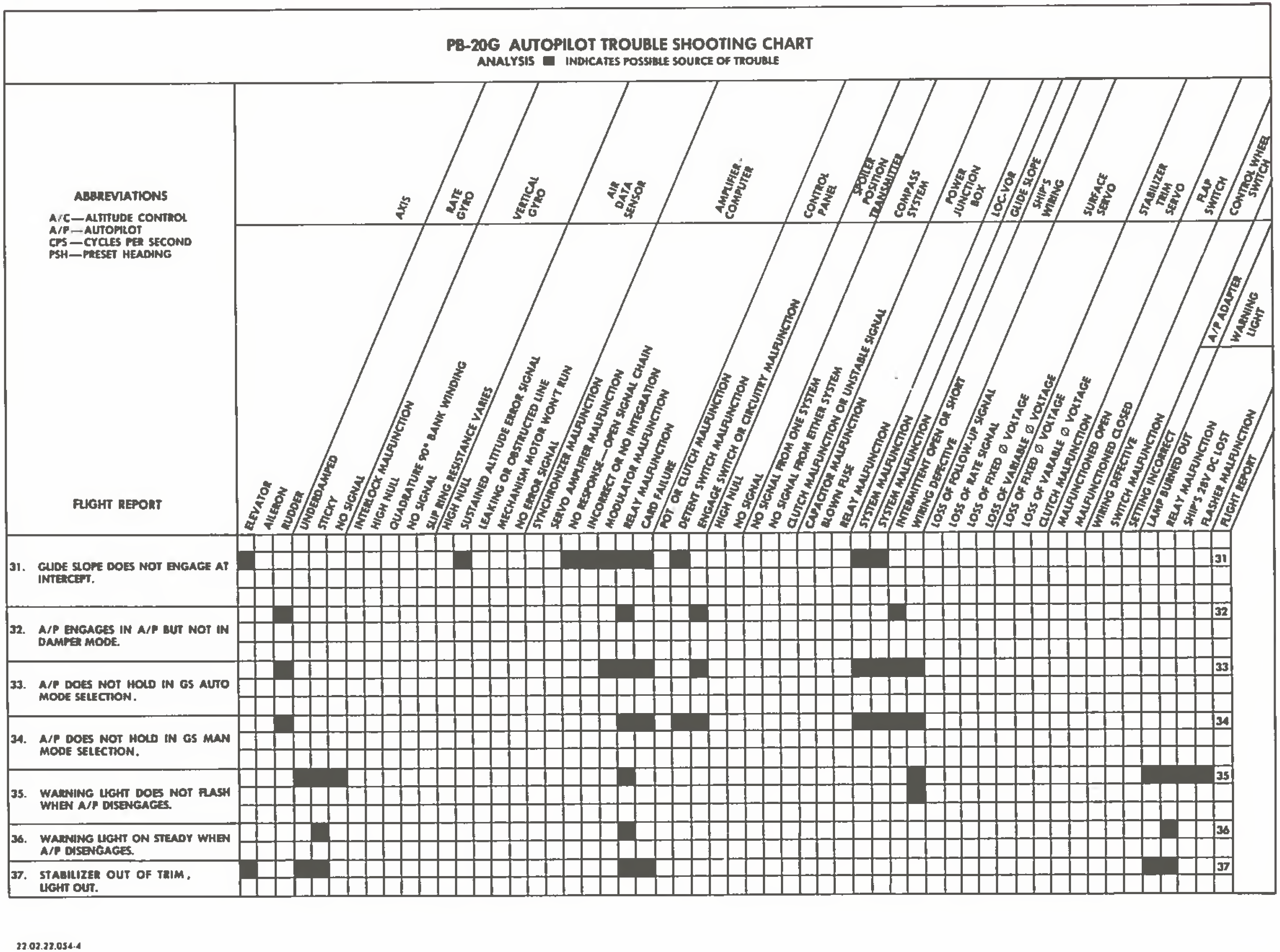
Autopilot Trouble Shooting Chart
Figure 105 (Sheet 2 of 8)



Autopilot Trouble Shooting Chart
Figure 105 (Sheet 1 of 8)



Autopilot Trouble Shooting Chart
Figure 105 (Sheet 3 of 8)



Autopilot Trouble Shooting Chart
Figure 105 (Sheet 4 of 8)

AUTOPILOT SYSTEM - TROUBLE SHOOTING

1. General

Faulty operation of the autopilot system will usually appear in, and should be analyzed in terms of, the three control surface signal channels. Switching faults and failures may also be limited to a single channel. Trouble shooting can thus be localized in the signal chain of the faulty channel, instead of requiring a check of the entire autopilot system through the rudder, aileron, and elevator channels.

Rudder, aileron, and elevator control signal channels comprise individual circuit elements, except for the common control circuits of the autopilot control panel. Plug-in amplifiers and relays in the amplifier-computer can be replaced by removing the cover of the unit, unplugging the defective amplifier or relay, and plugging in a new card.

The card amplifiers are identified by type numbers. This marking corresponds to the designation of amplifiers in the channel servo loop schematics of Figures 3 through 8. For example, when trouble shooting the rudder channel, a suspected amplifier card in the rudder signal chain can be replaced by a known good card. The cards are indexed so that only the correct card can be plugged into an amplifier-computer receptacle.

Engage switching faults may be localized to rudder, aileron, or elevator channels by observing the functions impaired by the selections made on the autopilot control panel. The cause of engage switching troubles may lie in the control panel, the amplifier-computer, the power junction box, or other parts of the interlock circuits. The schematics of Figure 9 show how each relay is energized. Figures 101 through 104 show the pin numbers of the major components through which relays and amplifier card circuits connect into the autopilot system.

The trouble shooting charts of Figure 105 should be used to help analyze the possible source of trouble in the autopilot system, and to determine the order in which to make tests or replace components.

The pattern of control switching is determined by the manual setting of autopilot control panel switches and controls. Autopilot or damper engagement, mode selection, and turn or pitch control actuation, all imply automatic switching by relays. The schematic diagrams of Figure 8 show how relay solenoids are energized.

The relay contacts are shown in the unenergized position in the schematics of Figure 8. Relay contacts shown open can be closed by energizing the relay solenoids. These schematic diagrams emphasize the inter-relation of automatic control switching relays and manual switching. Failure of a relay to function may disengage the autopilot, or it may impair the operation of a specific function. The schematic diagrams will, therefore, be useful for system analysis and trouble shooting.

Amplifier-computer relay assemblies are plug-in types that are easily removed and replaced for testing and maintenance. The trim warning time-delay relay and the flap position relay are installed on the lower shelf of the electrical compartment rack forward of the air data computer.

and the stabilizer trim servo motor and position the elevator. The magnetic amplifier output phase determines the direction of movement of the elevator surfaces, and the output voltage amplitude determines the speed of servo motor operation.

As the elevator servo motor turns, it drives the servo rate generator and the servo follow-up Autosyn synchro. The rate generator feeds a signal back into the input of the servo amplifier to damp servo motor oscillations. The torque limiting resistor limits the maximum torque that can be applied to the control cables. The follow-up synchro feeds a signal back into the elevator signal control chain at the input to the pitch control limiter amplifier. Follow-up synchro signals null the elevator channel signals and stop the servo motors when the elevator reaches the required position.

When a load is held by the elevator control surface, the stabilizer trim servo drives the stabilizer until this load is removed.

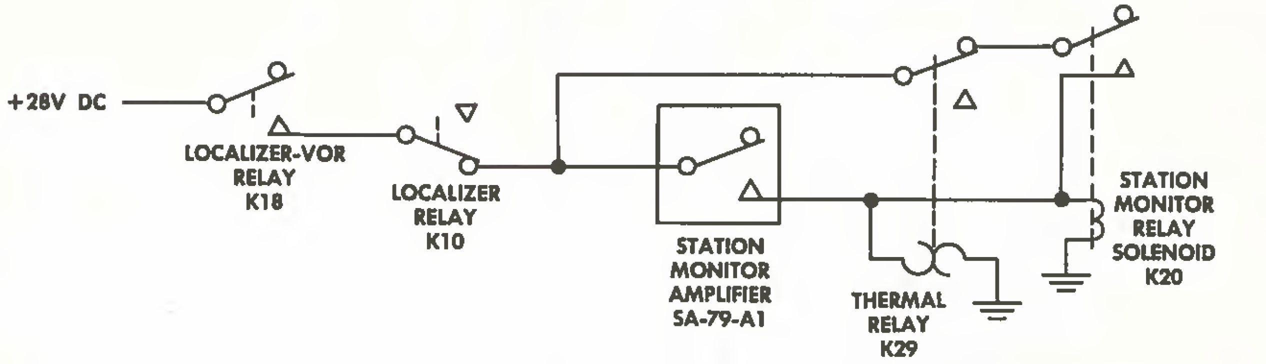
(4) Elevator Trim Indication. Magnetic amplifier output actuates the trim servo indicator. The amount of trim indicator displacement from center is proportional to the amplitude of the elevator channel output voltage; and the direction of displacement depends upon the output voltage phase being supplied to the elevator servo and stabilizer trim servo motors. Displacement of the indicator bar indicates that the airplane is out of trim and that the elevator is holding a load.

(5) Trim Warning Light. The trim warning light illuminates to show stabilizer movement against autopilot control, and illuminates if the stabilizer trim system fails. With flaps up the time-delay relay prevents trim warning light response to quick transients by introducing a delay of 3.25 seconds. When the flaps are lowered the flap position switch energizes the flap position relay, and contacts of the relay change the time delay to 1.0 second.

G. Control Switching.

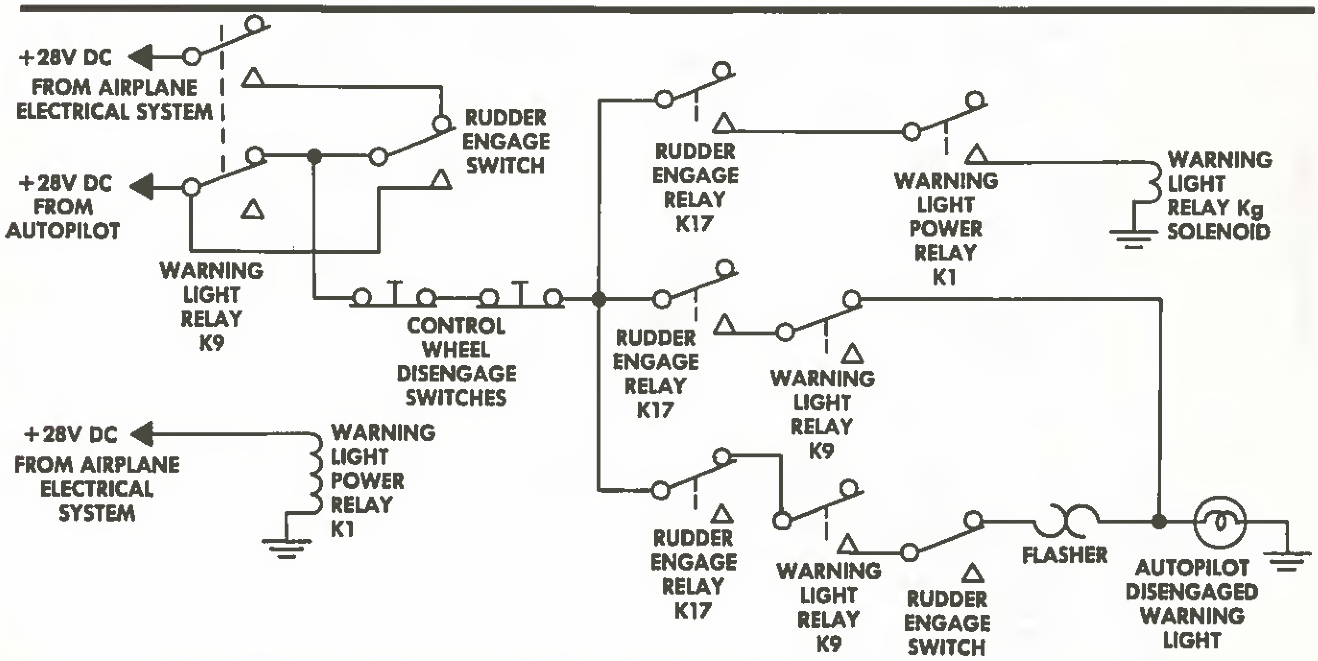
Electrical power interlock circuits must be satisfied before the autopilot system can be engaged and switching relays must be energized for various modes of autopilot operation. Autopilot engagement is interlocked with airplane electrical power. If any phase of the airplane ac electrical system loses power, the autopilot system positively disengages. The system thus conforms to fail-safe principles of operation.

All autopilot system relays are energized by dc power developed within the autopilot junction box from the 3-phase airplane power input. However, 28-volts dc from the airplane electrical system energizes the autopilot warning light and the warning light relay. If the autopilot disengages because of loss of 3-phase power or failure of relays to operate, the warning light illuminates to warn the pilots.



LOC-VOR MODE SELECTION CAUSES THE LOCALIZER-VOR RELAY CONTACTS TO CLOSE. TO-FROM AMBIGUITY SIGNALS MAINTAIN THE SWITCH IN THE STATION MONITOR AMPLIFIER SA-79-A1 OPEN UNTIL THE AIRPLANE ENTERS THE CONE OF CONFUSION OVER THE OMNI STATION. AT THIS TIME THE AMBIGUITY SIGNALS ARE LOST, THE STATION MONITOR AMPLIFIER SWITCH CLOSES, THE STATION MONITOR RELAY ENERGIZES, AND THERMAL RELAY BEGINS A CYCLE OF 140 SECONDS. AT THE SAME TIME THE STATION MONITOR RELAY LOCKS IN THROUGH ITS OWN CONTACTS AND THE CONTACTS OF THE THERMAL RELAY. AFTER THE AIRPLANE LEAVES THE CONE OF CONFUSION THE AMBIGUITY SIGNALS CAUSE THE STATION MONITOR AMPLIFIER SWITCH TO OPEN; AND AFTER 140 SECONDS THE THERMAL RELAY CONTACTS OPEN. THE STATION MONITOR RELAY THEN DEENERGIZES.

STATION MONITOR RELAY CONTROL

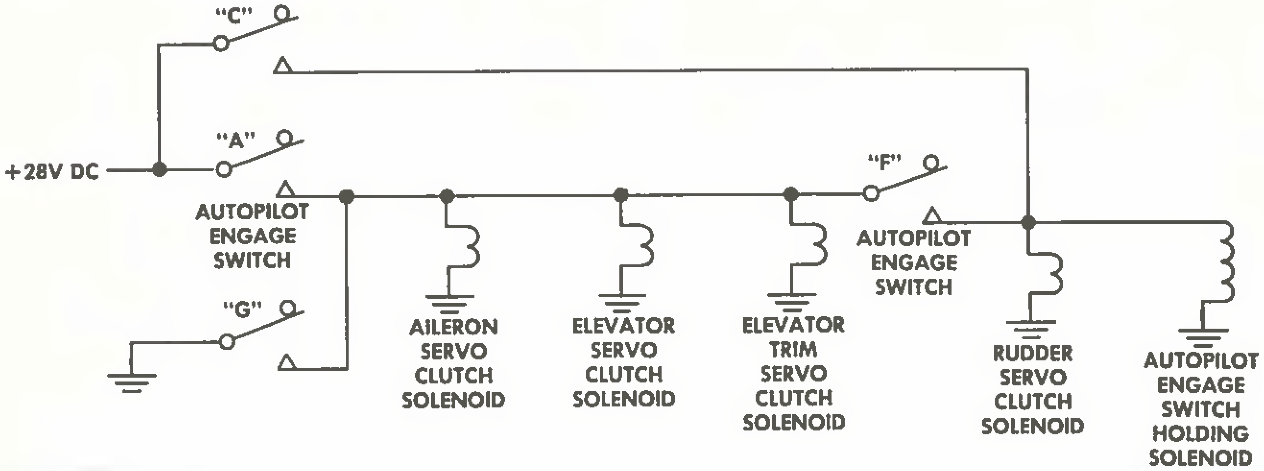


THE AUTOPILOT DISENGAGE WARNING LIGHT ILLUMINATES WHEN THE AUTOPILOT DISENGAGES AUTOMATICALLY BECAUSE OF AN INTER LOCK MALFUNCTION, WHEN A RELAY FAILS TO OPERATE, OR WHEN 28-VOLT DC POWER FROM THE AIRPLANE ELECTRICAL SYSTEM FAILS. THE WARNING LIGHT FLASHES INTERMITTENTLY IF THE AUTOPILOT DISENGAGES AUTOMATICALLY, GLOWS STEADILY IF THE MALFUNCTION IS DUE TO ANOTHER CAUSE. WHEN AIRPLANE 28-VOLT DC POWER IS LOST, THE WARNING LIGHT RELAY DEENERGIZES AND CONNECTS 28-VOLT DC AUTOPILOT SYSTEM POWER, BYPASSING THE WARNING LIGHT FLASHER; AND THE WARNING LIGHT GLOWS STEADILY. EITHER THE STEADY WARNING LIGHT OR THE FLASHING WARNING LIGHT CAN BE EXTINGUISHED BY DEPRESSING A CONTROL WHEEL DISENGAGE SWITCH. LOSS OF 28-VOLT DC AIRPLANE POWER DOES NOT NECESSARILY IMPAIR AUTOPILOT OPERATION.

22.02.22.023-10

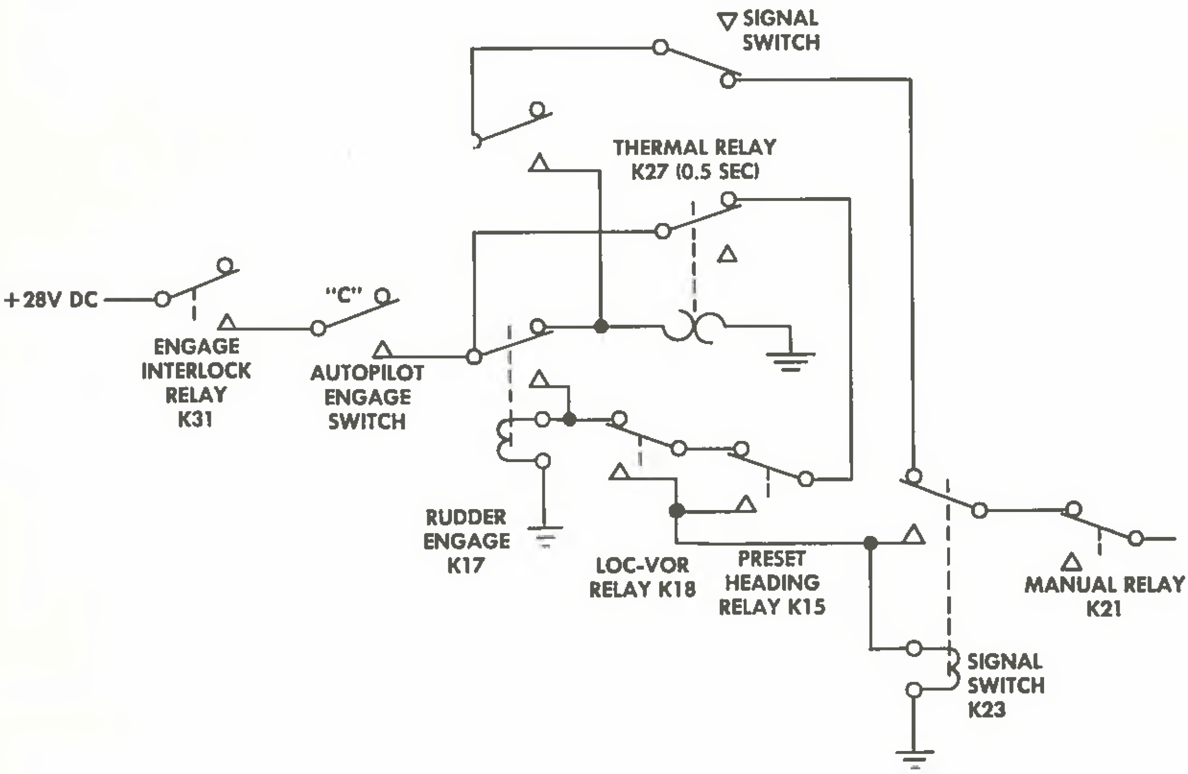
WARNING LIGHT RELAY AND WARNING LIGHT CONTROL

Autopilot Control Switching Circuits,
Schematic Diagrams
Figure 8 (Sheet 10 of 10)



AUTOPILOT ENGAGE SWITCH CONTACTS "A" AND "F" ARE BOTH CLOSED WHEN THE AUTOPILOT IS ENGAGED IN AUTOPILOT MODE. CONTACT "C" AND CONTACT "G" ARE CLOSED, AND CONTACT "F" IS OPEN IN DAMPER MODE OF OPERATION. CONTACTS "G" AND "F" ARE CLOSED WHEN THE AUTOPILOT IS OFF, TO PROVIDE POSITIVE DISENGAGEMENT OF SURFACE SERVO CLUTCHES.

SERVO CLUTCH CONTROL

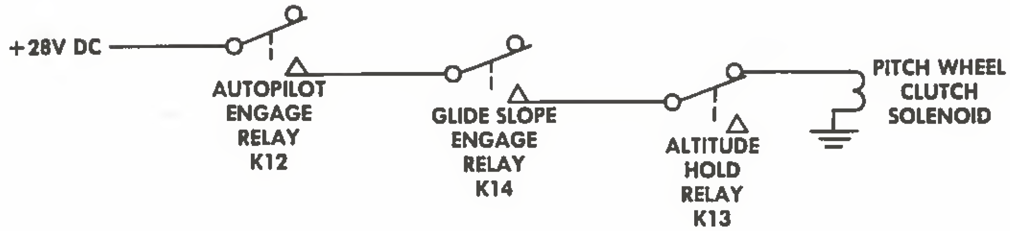


THE SIGNAL SWITCH RELAY ENERGIZES WHEN THE SIGNAL TO THE SIGNAL SWITCH AMPLIFIER IS SUFFICIENT TO DROP OUT THE SIGNAL SWITCH THROUGH A 0.5 SECOND TIME DELAY RELAY, K27. ACTUATION OF THE SIGNAL SWITCH RELAY OCCURS ONLY IN HDG, LOC-VOR, GS AUTO, OR GS MAN MODES.

22.02.22.023-9A

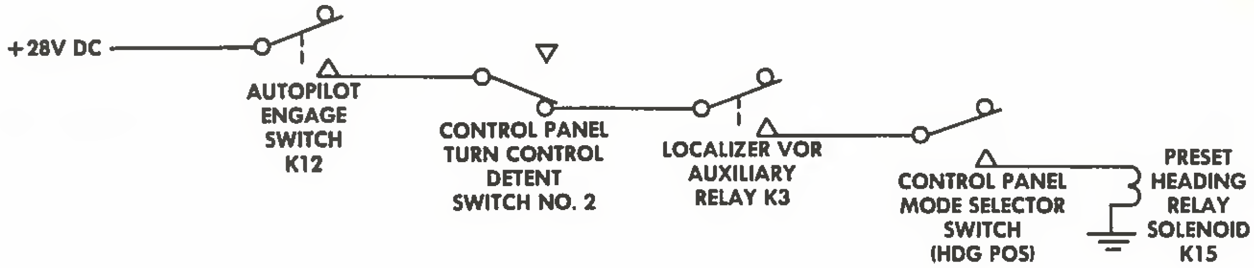
SIGNAL SWITCH RELAY CONTROL

Autopilot Control Switching Circuits,
Schematic Diagrams
Figure 8 (Sheet 9 of 10)



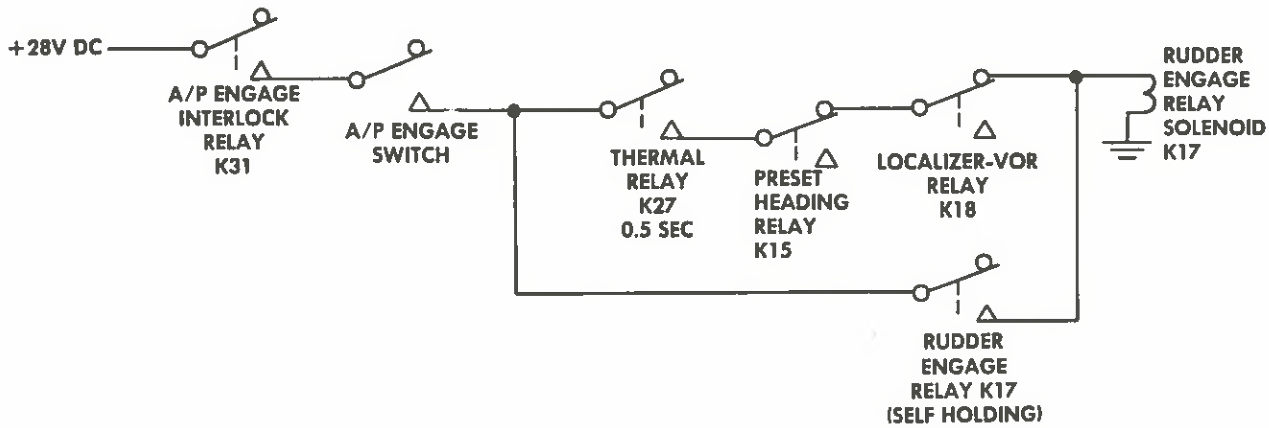
THE PITCH WHEELS OF THE AUTOPILOT CONTROL PANEL ARE CLUTCHED TO THE PITCH SIGNAL POTENTIOMETERS EXCEPT DURING ALTITUDE HOLD OR GLIDE SLOPE MODE OF OPERATION.

PITCH WHEEL CLUTCH CONTROL



PRESET HEADING RELAY ENERGIZES WHEN HDG MODE IS SELECTED.

PRESET HEADING RELAY CONTROL

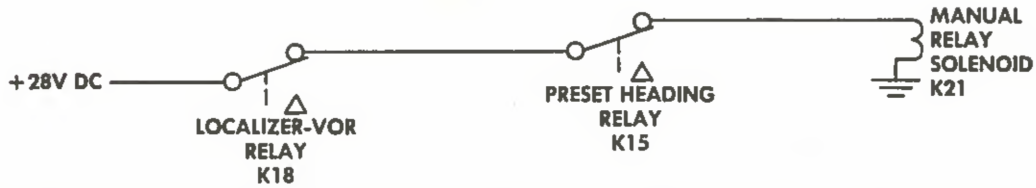


ENGAGEMENT OF THE AUTOPILOT OR THE YAW DAMPER APPLIES 28-VOLT DC TO THE THERMAL RELAY, WHICH COMPLETES THE CIRCUIT TO ENERGIZE THE RUDDER ENGAGE RELAY AFTER A DELAY OF ONE-HALF SECOND. SELF-HOLDING CONTACTS OF THE RUDDER ENGAGE RELAY THEN HOLD THE RELAY IN.

RUDDER ENGAGE RELAY CONTROL

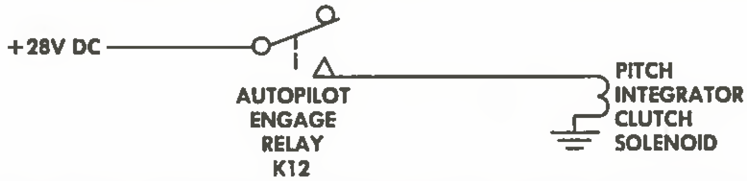
22.02.22.023-8

Autopilot Control Switching Circuits,
Schematic Diagrams
Figure 8 (Sheet 8 of 10)



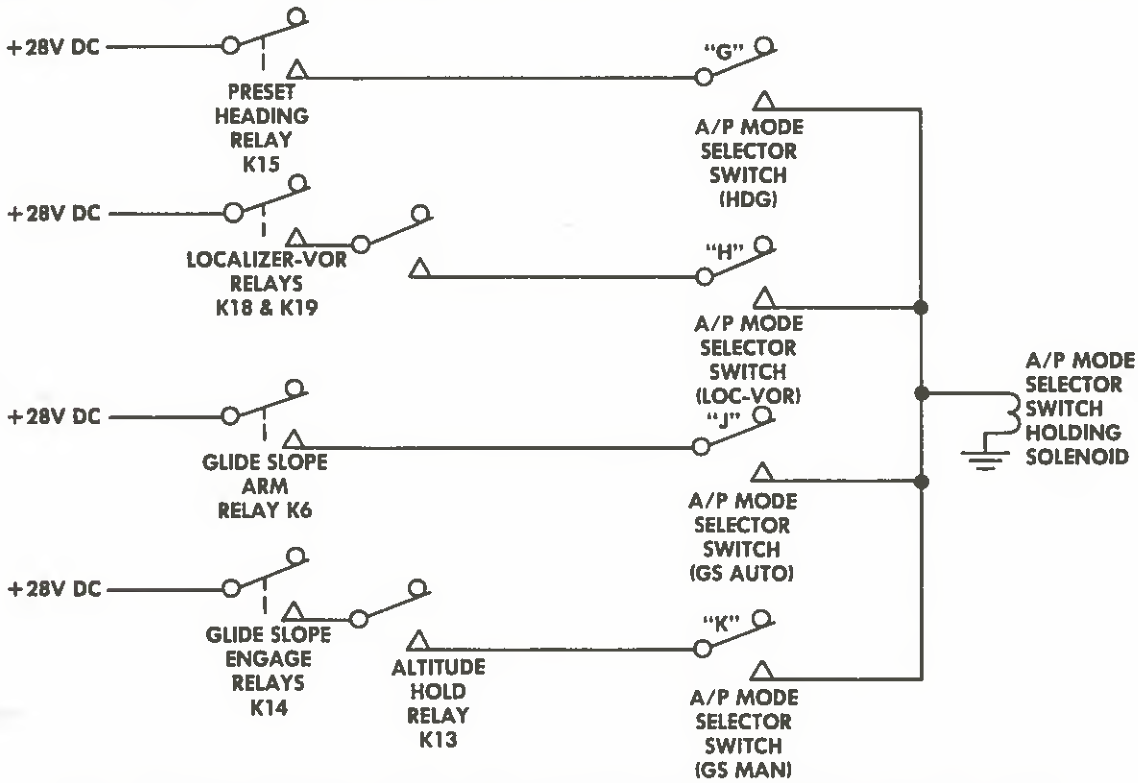
THE MANUAL RELAY ENERGIZES THROUGH UNACTUATED CONTACTS OF THE LOCALIZER-VOR AND THE PRESET HEADING RELAYS AND DEENERGIZES WHEN EITHER OF THESE RELAYS ENERGIZES. THE LOCALIZER-VOR RELAY ENERGIZES WHEN LOC-VOR, GS AUTO, OR GS MAN MODE IS SELECTED. THE PRESET HEADING RELAY ENERGIZES WHEN HDG MODE IS SELECTED. THE MANUAL RELAY IS THEREFORE ENERGIZED ONLY WHEN THE MODE SELECTOR SWITCH IS IN MAN POSITION. THE MANUAL RELAY INTERVENES IN THE SELF-HOLDING FUNCTION OF THE SIGNAL SWITCH RELAY.

MANUAL-VOR RELAY CONTROL



THE PITCH INTEGRATOR AUTOSYN IS CLUTCHED IN WHEN AUTOPILOT IS ENGAGED. THE MOTOR OF THE INTEGRATOR WILL NOT OPERATE UNTIL ITS FIXED PHASE IS ENERGIZED. THE FIXED PHASE IS ENERGIZED WHEN ALTITUDE HOLD IS ENGAGED OR WHEN GLIDE SLOPE MODE IS SELECTED.

PITCH INTEGRATOR CLUTCH CONTROL

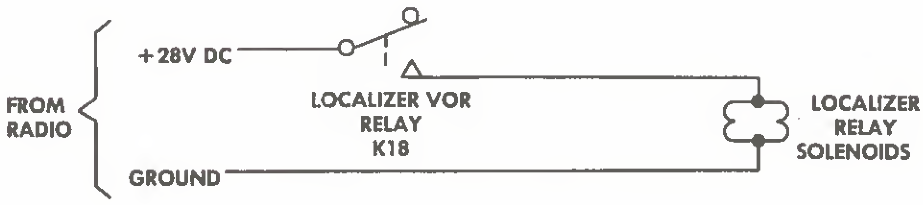


THE AUTOPILOT CONTROL PANEL MODE SELECTOR SWITCH IS SPRING-LOADED TO MAN POSITION AND SOLENOID-HELD TO HDG, LOC-VOR, GS AUTO, OR GS MAN POSITION, IF THE AUTOPILOT IS ENGAGED AND INTERLOCKS ARE SATISFIED.

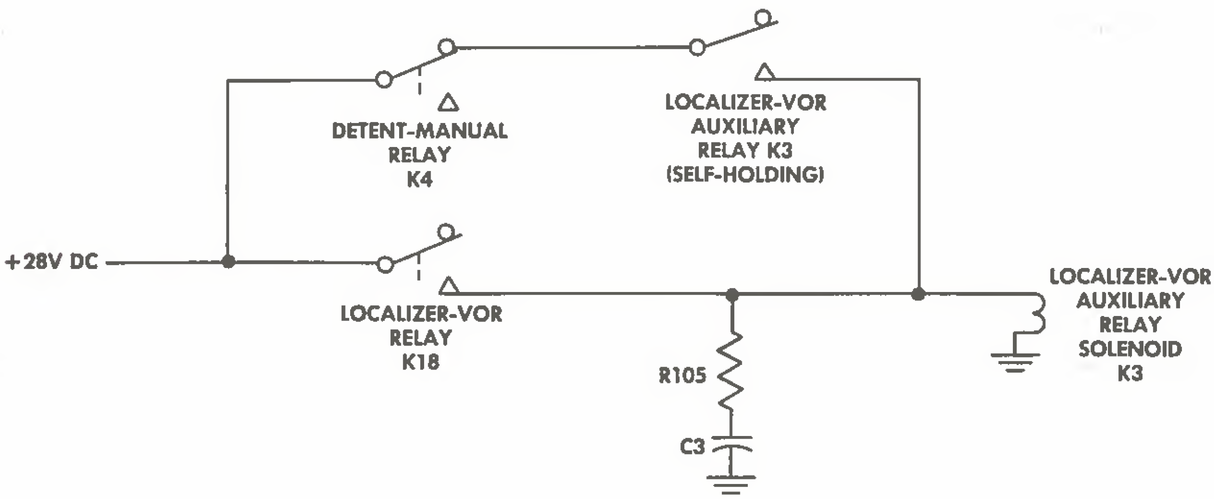
22.02.22.023-7

PITCH WHEEL CLUTCH CONTROL

Autopilot Control Switching Circuits,
Schematic Diagrams
Figure 8 (Sheet 7 of 10)

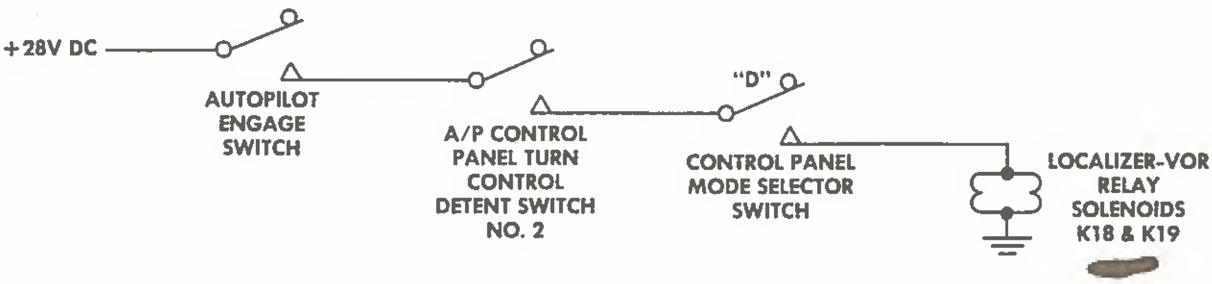


LOCALIZER RELAY CONTROL



THE LOCALIZER-VOR AUXILIARY RELAY IS SELF-HOLDING THROUGH ITS OWN CONTACTS IF THE MODE SELECTOR SWITCH IS IN HDG OR LOC-VOR POSITION. IN MAN, GS, AUTO, OR GS MAN POSITION OF THE CONTROL PANEL MODE SELECTOR SWITCH THE DETENT-MANUAL RELAY IS ENERGIZED, AND THE 28-VOLT DC CIRCUIT THROUGH THE SELF-HOLDING CONTACTS IS INTERRUPTED. THE TIME REQUIRED FOR THE RELAY TO DROP OUT IS INCREASED BY THE RESISTOR-CAPACITOR NETWORK CONNECTED ACROSS THE SOLENOID.

LOCALIZER-VOR AUXILIARY RELAY CONTROL

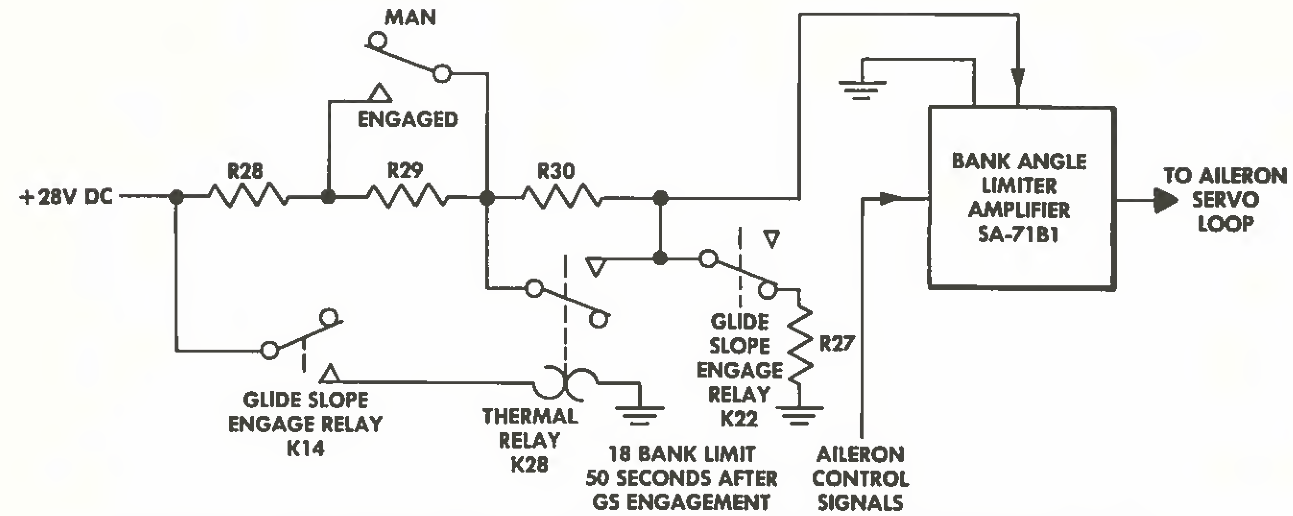


THE LOCALIZER-VOR RELAYS ARE ENERGIZED THROUGH THE CONTROL PANEL MODE SELECTOR SWITCH WHEN LOC-VOR, GS AUTO, OR GS MAN MODE IS SELECTED.

LOCALIZER-VOR RELAY CONTROL

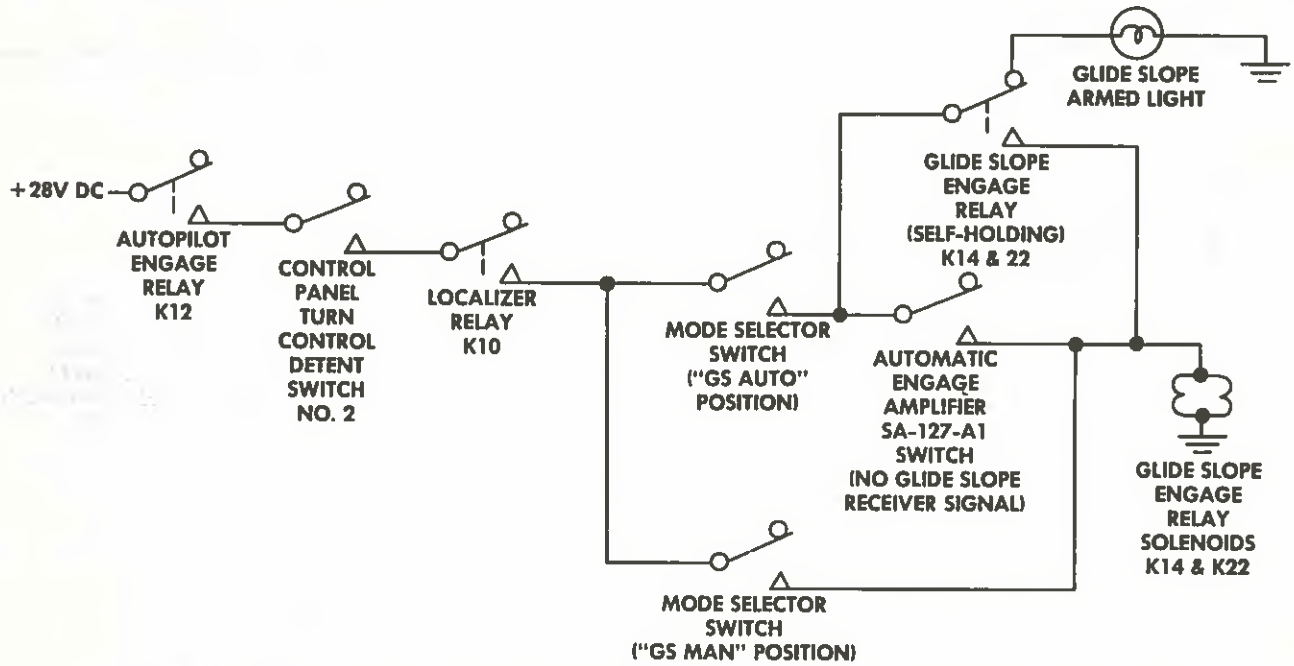
22.02.22-023-6

Autopilot Control Switching Circuits, Schematic Diagrams
Figure 8 (Sheet 6 of 10)



BANK ANGLE LIMITATION CHANGES FROM 30 DEGREES WITHOUT GLIDE SLOPE ENGAGEMENT TO 18 DEGREES WHEN GLIDE SLOPE IS ENGAGED. THERMAL RELAY K28 DELAYS THE CHANGE FOR 60 SECONDS AFTER GLIDE SLOPE ENGAGEMENT.

GLIDE SLOPE BANK LIMITER CIRCUIT



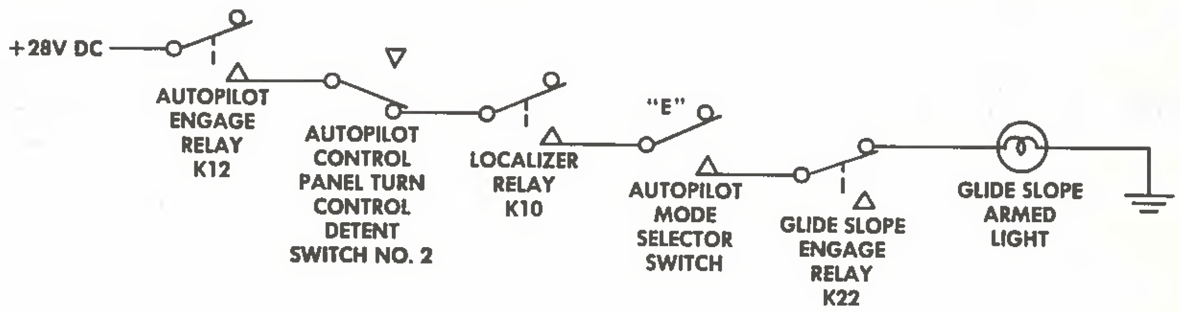
GS AUTO MODE SELECTION ENERGIZES THE GLIDE SLOPE ENGAGE RELAYS WHEN THE GLIDE SLOPE RECEIVER SIGNAL REACHES A VALUE THAT ACTUATES THE AUTOMATIC ENGAGE AMPLIFIER SA-127-A1 SWITCH. SELF-HOLDING CONTACTS OF THE RELAYS THEN HOLD THE RELAYS IN, AND SIMULTANEOUSLY EXTINGUISH THE GLIDE SLOPE ARMED LIGHT THAT ILLUMINATES WHEN GS AUTO IS SELECTED. THE LIGHT EXTINGUISHES TO SHOW THAT THE GLIDE SLOPE BEAM HAS BEEN INTERCEPTED.

GS MAN MODE SELECTION ENERGIZES THE GLIDE SLOPE RELAYS DIRECT THROUGH THE MODE SELECTOR SWITCH AND EXTINGUISHES THE GLIDE SLOPE ARMED WARNING LIGHT IF THE LIGHT WAS ILLUMINATED BY A PREVIOUS GS AUTO SELECTION ON THE MODE SELECTOR SWITCH.

22.02.22.023-5

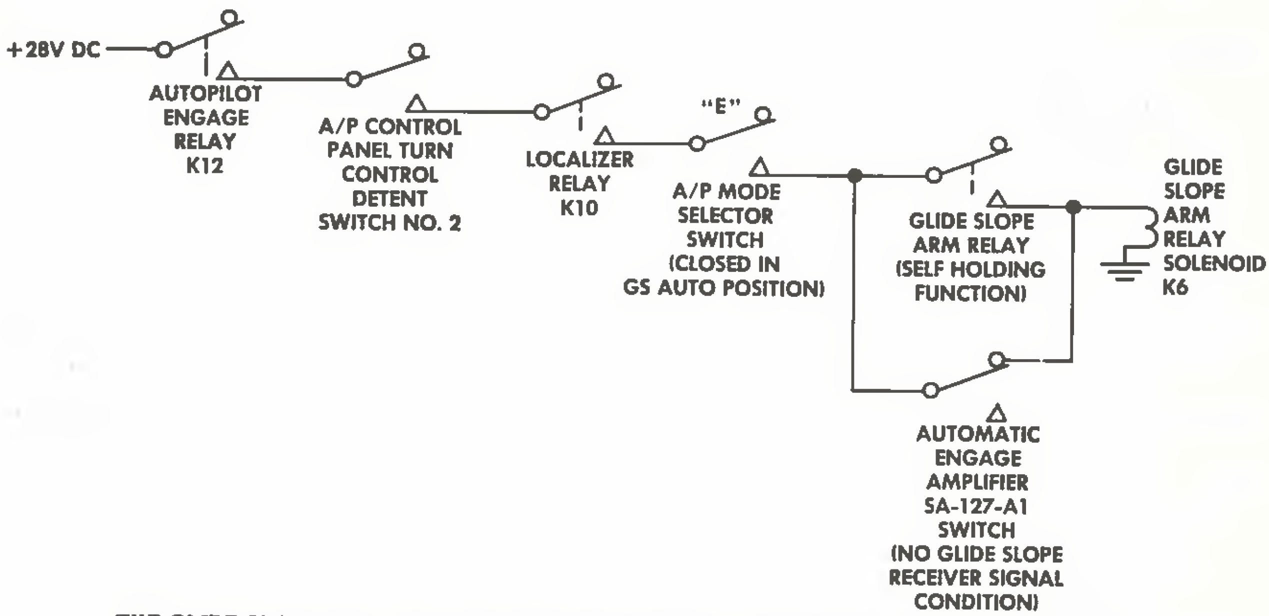
GLIDE SLOPE ENGAGE RELAY CONTROL

Autopilot Control Switching Circuits,
Schematic Diagrams
Figure 8 (Sheet 5 of 10)



SELECTION OF GS AUTO MODE ON THE CONTROL PANEL SELECTOR SWITCH CAUSES THE GLIDE SLOPE ARMED LIGHT TO ILLUMINATE. WHEN THE GLIDE SLOPE RECEIVER CAPTURES THE GLIDE SLOPE BEAM SIGNAL, THE AUTOMATIC ENGAGE SIGNAL SWITCH AMPLIFIER SA-127-A1 ENERGIZES THE GLIDE SLOPE ENGAGE RELAY. A SET OF CONTACTS OF THIS RELAY OPENS THE 28-VOLT DC CIRCUIT TO THE GLIDE SLOPE ARMED LIGHT AND EXTINGUISHES THE LIGHT. ROTATING THE MODE SELECTOR FROM GS AUTO POSITION TO GS MAN POSITION ALSO EXTINGUISHES THE LIGHT BY OPENING THE GLIDE SLOPE ENGAGE RELAY CONTACTS.

GLIDE SLOPE ARMED LIGHT CONTROL

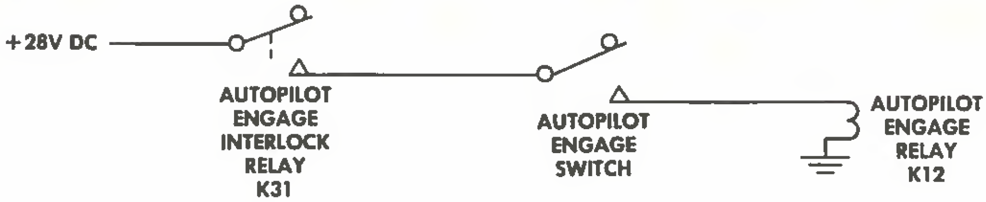


THE GLIDE SLOPE ARM RELAY SOLENOID ENERGIZES WHEN THE GLIDE SLOPE RECEIVER SUPPLIES A SIGNAL TO THE AUTOMATIC ENGAGE SIGNAL SWITCH AMPLIFIER SA-127-A1. SELF-HOLDING CONTACTS OF THE RELAY KEEP THE RELAY ENERGIZED AS LONG AS THE AUTOPILOT MODE SELECTOR SWITCH ON THE CONTROL PANEL REMAINS IN GS AUTO POSITION, WITH THE AUTOPILOT ENGAGED. CONTACTS OF THE GLIDE SLOPE ARM RELAY MUST CLOSE TO COMPLETE THE ELECTRICAL POWER CIRCUIT OF THE MODE SELECTOR SWITCH HOLDING SOLENOID IN GS AUTO MODE. THESE CONTACTS CLOSE WHEN THE RELAY IS ENERGIZED.

22.02.22.023-4

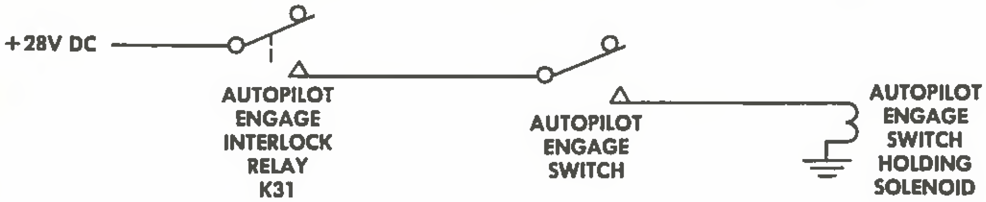
GLIDE SLOPE ARM RELAY CONTROL

Autopilot Control Switching Circuits,
Schematic Diagrams
Figure 8 (Sheet 4 of 10)



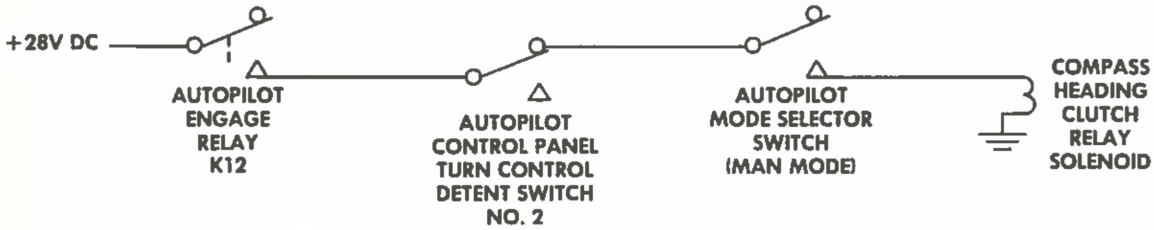
AUTOPILOT ENGAGE RELAY ENERGIZES WHEN AUTOPILOT-DAMPER SWITCH ON CONTROL PANEL IS ACTUATED TO EITHER POSITION, IF AUTOPILOT INTERLOCK REQUIREMENTS ARE SATISFIED.

AUTOPILOT ENGAGE RELAY CONTROL



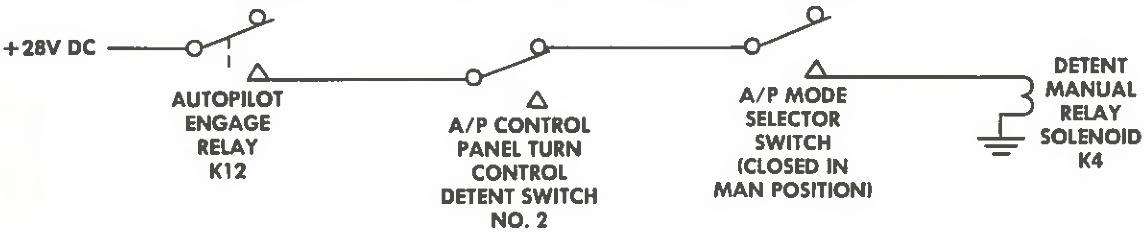
ENGAGE SWITCH HOLDING SOLENOID HOLDS CONTROL PANEL ENGAGE SWITCH IN AUTOPILOT POSITION, IF AUTOPILOT INTERLOCK REQUIREMENTS ARE SATISFIED.

AUTOPILOT ENGAGE SWITCH HOLDING CONTROL



A REMOTE COMPASS OUTPUT AUTOSYN SYNCHRO IS CLUTCHED IN AND SUPPLIES COMPASS INFORMATION TO THE AUTOPILOT SYSTEM WHEN THE CONTROL PANEL MODE SELECTOR SWITCH IS IN MAN POSITION. AUTOPILOT MUST BE ENGAGED AND TURN KNOB MUST BE IN CENTER DETENT POSITION.

COMPASS HEADING CLUTCH RELAY CONTROL

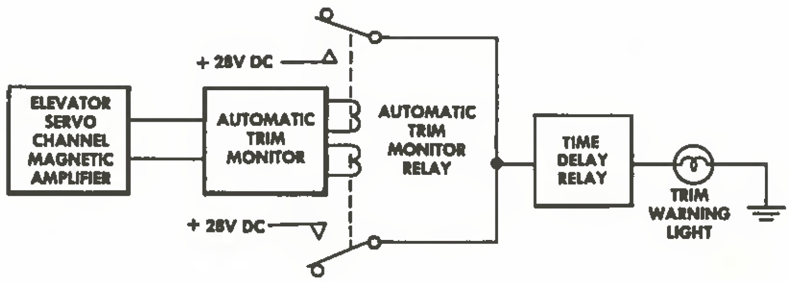


THE DETENT-MANUAL RELAY REMAINS UNENERGIZED WITH THE CONTROL PANEL MODE SELECTOR SWITCH IN MAN, GS AUTO, OR GS MAN POSITION. THIS RELAY INTERVENES IN THE LOCALIZER-VOR AUXILIARY RELAY CIRCUIT TO LOCK THE RELAY IN AFTER LOC-VOR OR HDG MODE HAS BEEN SELECTED. ACTUATING THE MODE SELECTOR SWITCH TO MAN POSITION FROM LOC-VOR POSITION OPENS THE LOCALIZER-VOR AUXILIARY RELAY CIRCUIT AND RELEASES THE LOCALIZER-VOR AUXILIARY RELAY AFTER A 0.1 SECOND DELAY DURING WHICH A CAPACITOR DISCHARGES THROUGH THE SOLENOID WINDINGS OF THE LOCALIZER-VOR AUXILIARY RELAY. DURING THE DELAY PERIOD ANY AILERON INTEGRATION IS ZEROED OUT BECAUSE THE AILERON INTEGRATION CLUTCH SOLENOID IS DEENERGIZED. AFTER THE DELAY PERIOD ENDS THE AILERON INTEGRATION CLUTCH SOLENOID IS AGAIN ENERGIZED THROUGH THE UNACTUATED CONTACTS OF THE LOCALIZER-VOR AUXILIARY RELAY.

22.02.22.023-3

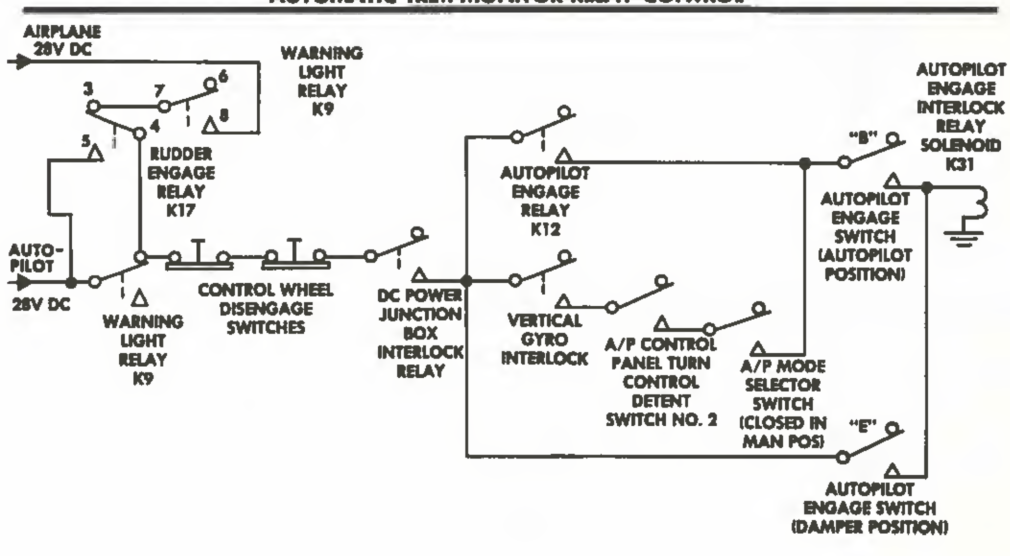
DETENT MANUAL RELAY CONTROL

Autopilot Control Switching Circuits,
Schematic Diagrams
Figure 8 (Sheet 3 of 10)



STEADY DYNAMIC LOAD ON THE ELEVATOR ENERGIZES THE AUTOMATIC TRIM MONITOR AND ILLUMINATES THE TRIM WARNING LIGHT ON THE ENGINE INSTRUMENT PANEL TO SHOW OUT-OF-TRIM CONDITION AT ALL TIMES.
THE TIME-DELAY RELAY DELAYS THE TRIM WARNING LIGHT TO PREVENT RESPONSE TO QUICK TRANSIENTS. THE DELAY IS 3.25 SECONDS WITH FLAPS UP, 1.0 SECOND WITH FLAPS DOWN.

AUTOMATIC TRIM MONITOR RELAY CONTROL

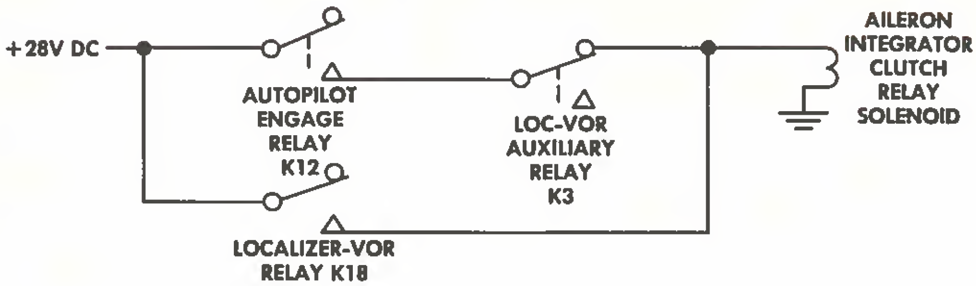


THE AUTOPILOT ENGAGE INTERLOCK RELAY IS A MONITOR RELAY. INTERRUPTION OF 28 VOLTS DC TO THE ENGAGE INTERLOCK RELAY SOLENOID DISENGAGES THE AUTOPILOT SYSTEM FROM AUTOPILOT OR DAMPER MODE OF OPERATION. IF THE AUTOPILOT DISENGAGES AUTOMATICALLY, THE DISENGAGED WARNING LIGHT FLASHES ON THE ENGINE INSTRUMENT PANEL. DISENGAGED WARNING LIGHT CAN BE EXTINGUISHED AND THE AUTOPILOT SYSTEM CAN BE DISENGAGED BY DEPRESSING A CONTROL WHEEL DISENGAGE SWITCH.

AUTOPILOT ENGAGE INTERLOCK RELAY CONTROL

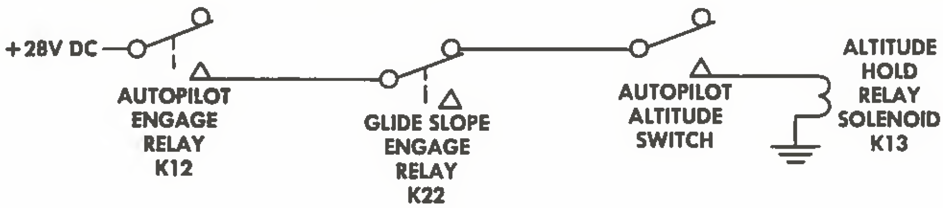
22.02.22.023-2C

Autopilot Control Switching Circuits,
Schematic Diagrams
Figure 8 (Sheet 2 of 10)



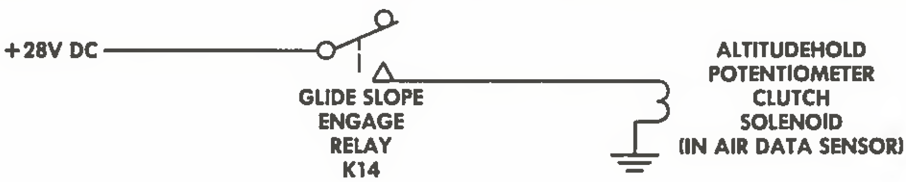
AILERON INTEGRATOR AUTOSYN IS CLUTCHED IN WHEN THE AUTOPILOT IS ENGAGED. THE MOTOR OF THE INTEGRATOR WILL NOT OPERATE UNTIL ITS FIXED PHASE IS ENERGIZED BY SELECTION OF HDG, MAN, OR LOC-VOR MODE. RETURN TO MANUAL MODE FROM LOC-VOR SELECTION PERMITS INTEGRATION BUILT-UP DURING LOC-VOR OPERATION TO BE ZEROED OUT BY 0.1 SECOND DELAY IN DEENERGIZING THE LOCALIZER-VOR AUXILIARY RELAY.

AILERON INTEGRATOR CLUTCH CONTROL



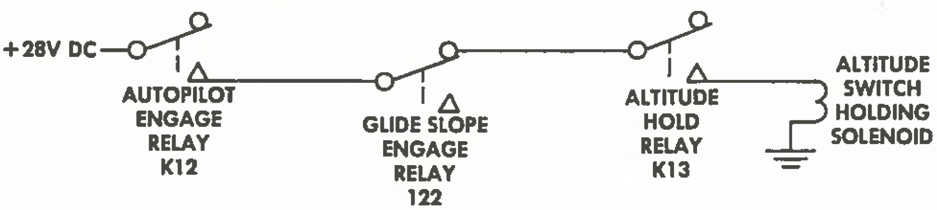
ALTITUDE HOLD ENGAGES WITH THE MODE SELECTOR SWITCH IN HDG, MAN, LOC-VOR, OR GS AUTO MODE. ALTITUDE HOLD DISENGAGES AUTOMATICALLY WHEN GLIDE SLOPE BEAM CAPTURE OCCURS, OR WHEN THE MODE SELECTOR SWITCH IS ACTUATED TO GS MAN POSITION.

ALTITUDE HOLD RELAY CONTROL



ENGAGEMENT OF ALTITUDE HOLD MODE CLUTCHES THE AUTOSYN SYNCHRO TO THE MOTOR IN THE ALTITUDE PART OF THE AIR DATA SENSOR. THE AUTOSYN SYNCHRO SUPPLIES ALTITUDE ERROR SIGNALS FOR ALTITUDE CONTROL.

ALTITUDE POTENTIOMETER CLUTCH CONTROL



THE ALTITUDE SWITCH HOLDING SOLENOID IS ENERGIZED THROUGH UNACTUATED CONTACTS OF THE GLIDE SLOPE ENGAGE RELAY. ALTITUDE SWITCH CANNOT BE ENGAGED DURING GLIDE SLOPE OPERATION.

ALTITUDE SWITCH HOLDING CONTROL

22.02.22.023-1

Autopilot Control Switching Circuits,
Schematic Diagrams
Figure 8 (Sheet 1 of 10)

used, since altitude hold cannot be engaged. When GS AUTO or GS MAN mode is selected, the glide slope beam signal is attenuated as a function of altitude, and the altitude integrator is used to integrate any constant of glide slope beam error.

(c) Vertical Gyro. The vertical gyro pitch attitude signal is transformer-coupled into the input of the pitch attitude limiter amplifier.

The vertical gyro also supplies a signal proportional to the cosine of the bank angle of the airplane. This versine signal, which is generated by a locked-rotor Autosyn synchro in the vertical gyro, provides up-elevator control signals to overcome the tendency for the airplane to lose altitude during turns. The versine signal is attenuated by an airspeed potentiometer in the air data sensor and is then applied to the pitch attitude limiter input.

(d) Pitch Rate Gyro. The pitch rate gyro of the three-axis gyro unit feeds a rate signal into the input of the bandpass filter amplifier SA-78-B1. The amplifier output feeds into the aileron servo loop at the input to the preamplifier SA-104-A1, where it is mixed with the pitch angle limiter amplifier output signal.

(e) Glide Slope Receiver. When glide slope mode is selected, glide slope receiver signal is applied to the input of modulator-limiter amplifier SA-126-B1. The output of this amplifier is attenuated by the altitude section of air data sensor as a function of altitude, and is then mixed with other signals in the input to the pitch angle limiter amplifier. Part of the signal is applied to the integrator amplifier SA-32-A1 and the electromechanical integrator. The integrator output signal is then mixed with other signals in the input chain to the pitch angle limiter.

Glide slope modulator-limiter output is also fed to the automatic engage amplifier SA-127-A1. Refer to paragraph G for control switching and relay functions.

(3) Elevator Channel Output Signals. The output of the pitch attitude limiter amplifier is fed to the input of the preamplifier SA-104-A1. Preamplifier output is passed through an attenuating network and a limiter, and is applied to the input of servo amplifier SA-33-A1.

The servo amplifier drives the magnetic amplifier SA-40-C1, which raises the elevator signal chain voltage level to a value adequate to energize the variable phase windings of the elevator servo motor

of the three-axis gyro unit, the vertical gyro, the air deta sensor, and the glide slope receiver. These signals are combined and converted in the amplifier-converter, which develops control voltage of sufficient amplitude to energize the variable-phase windings of the elevator servo motor and the stabilizer trim servo motor to position the elevator control surfaces. The amplitude of the output control voltage determines the speed of operation of the servo motors, and the phase of the output voltage determines the direction of control surface movement.

Rotation of the elevator servo motor produces feedback signals from the servo rate generator and from the elevator position follow-up synchro. The feedback signals are introduced into the elevator channel servo loop by transformers, the position transmitter follow-up synchro signal being attenuated by a gain-setting potentiometer in the autopilot adapter. Figure 7 shows a simplified schematic diagram of the elevator channel signal chain in the amplifier-computer, and shows how the control and feedback signals are introduced into the amplifier-computer.

(1) Plug-in Cards. Most of the servo loop components of the amplifier-computer consist of plug-in, card-mounted circuits that simplify maintenance and trouble shooting. The card amplifiers use transistors, crystal diodes, small-size transformers, and torodial reactors. The cards are used as servo amplifiers, magnetic amplifiers, magnetic switches, limiters, and filters. Electromechanical computer cards and plug-in relays are also used. These plug-in units are easily removed and replaced.

(2) Elevator Channel Input Signals.

(a) Control Panel. Pitch control signals are introduced into the elevator signal chain by the pitch wheels. When altitude hold mode of operation is not selected on the control panel, the pitch wheels operate the wipers of the two potentiometers that select the phase and amplitude of pitch control signals. Pitch control signals are transformer-coupled into the elevator signal chain.

(b) Air Data Sensor. When altitude hold is engaged, an altitude error signal is first attenuated as a function of airspeed by a potentiometer in the air data sensor and is then transformer-coupled into the elevator at the input to the pitch attitude limiter amplifier SA-71-A1. A part of the air data sensor altitude signal is passed through integrator amplifier SA-32-A1 and an electromechanical intergrator, and is then mixed with the altitude signal at the input to the pitch angle limiter. During glide slope engagement, altitude error signal integration is not

Spoiler transmitter signals are also transformer-coupled into the aileron channel servo loop when the left and right spoilers are differentially positioned. Spoiler and servo follow-up feedback signals are mixed and then attenuated by a gain-setting potentiometer in the autopilot adapter. A part of the differential spoiler signal is crossfed to the rudder channel servo loop, as shown in Figure 4.

(3) Aileron Channel Output Signals. The aileron channel signals are applied to the input of preamplifier SA-104-A1, which, with its attenuating output network, has a gain of five. The preamplifier output is applied to the input of servo amplifier SA-33-A1, which, in turn, drives the magnetic amplifier SA-40-C1. The magnetic amplifier raises the control signal voltage level to a value adequate to drive the aileron servo motor and position the ailerons. The direction of aileron servo motor rotation is dependent upon the phase of the output voltage supplied by the amplifier, and the speed of rotation depends upon the amplitude of the signal.

As the servo motor turns, it drives the aileron servo rate generator and the aileron position follow-up synchro. The rate generator feeds a signal back into the input of the servo amplifier and the position transmitter feeds a signal back into the input of the preamplifier, as described in paragraph 2 E. Rate generator signals damp servo motor oscillations. Position transmitter signals null the aileron channel signals and stop the servo motor when the ailerons reach the required positions.

(4) Aileron Trim Indication. The indicator bar of the aileron trim indicator is displaced from center when the SA-40-C1 magnetic amplifier supplies output voltage. The amount of displacement is proportional to the output voltage; and the direction of displacement is dependent upon the phase of the voltage which the magnetic amplifier supplies to the variable-phase winding of the servomotor. Displacement of the indicator bar indicates that the airplane is out of trim, and that the control surfaces are holding an aerodynamic load.

F. Elevator Channel Operation.

Elevator channel control signals are fed into the autopilot amplifier-computer by the autopilot control panel, the pitch rate gyro

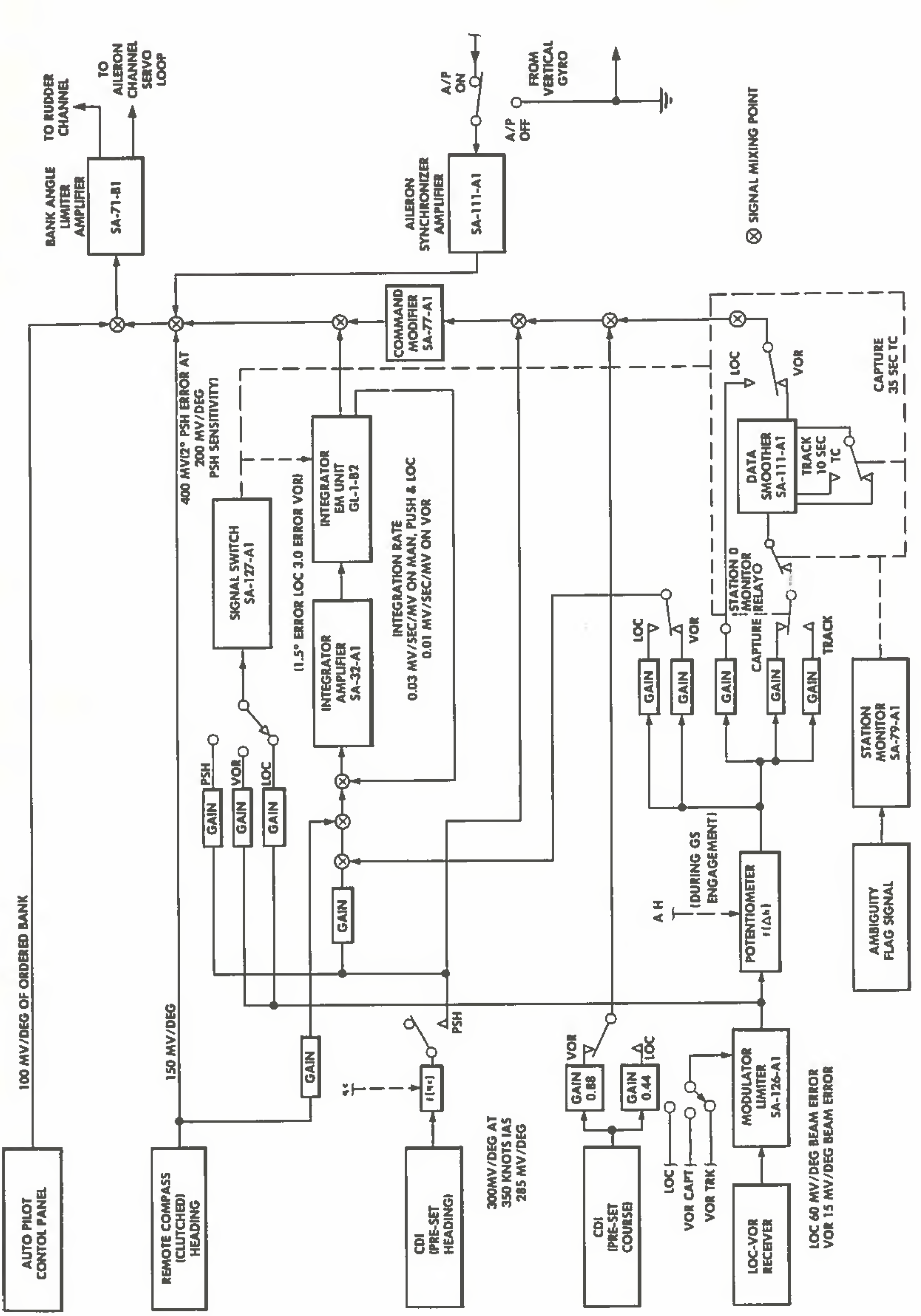
(c) Pre-set Heading. When a course is pre-set on the course deviation indicator and HDG mode is selected on the autopilot control panel, the compass signal is attenuated by the airspeed potentiometer of the air data sensor, and is then fed to the command modifier amplifier SA-77-A1. The command modifier amplifier provides a time constant to prevent the full roll signal from entering the signal chain. During the time constant the full roll signal builds up in increasing amounts as a function of time. The output of the command modifier amplifier feeds to the input of the bank angle limiter amplifier.

(d) VHF Navigation Receiver Control. When LOC-VOR mode of autopilot is selected on the autopilot control panel, localizer beam or VOR signals are fed to the modulator-limiter amplifier, where the dc signals are converted to 400 cps signals and are automatically limited by biasing arrangements during capture and tracking of radio signals. The output of the modulator-limiter is fed to the data smoother amplifier SA-111-C1. The data smoother output is fed to the input of the command modifier amplifier. Part of the modulator-limiter amplifier output is fed to the aileron integrator. The outputs of the command modifier and of the integrator are mixed and fed to the input of the bank angle limiter. Radio beam signal integration provides for "crabbing" in cross-winds to follow a VOR radial or an ILS beam.

On GS AUTO or GS MAN mode, the radio signal is attenuated by the altitude section of the air data sensor.

(e) Bank Attitude. All aileron channel signals discussed in the preceding paragraphs are mixed in the input to the bank angle limiter amplifier SA-71-A1. The bank angle limiter output is fed to the aileron channel servo loop, as shown in Figure 6. The bank angle limiter orders bank angle.

Bank angle limiter output is mixed with vertical gyro and roll-rate outputs. Before autopilot engagement, the bank angle limiter and the vertical gyro outputs are fed to the input of the aileron synchromizer amplifier SA-111-C1. The output of the aileron synchronizer amplifier is fed back to the input of the bank angle limiter amplifier. After autopilot engagement, the output of the aileron synchronizer is "washed out", and the vertical gyro bank angle transmitter supplies a follow-up measurement of the bank angle command. When the gyro bank signal is equal to and balances out the ordered bank angle, the bank angle order is satisfied, and the aileron servo follow-up has streamlined the control tabs.



Autopilot Aileron Channel Control Signals,
Block Diagram
Figure 5

A

to energize the variable-phase winding of the aileron servo motor and position the aileron control tab. The amplitude of the output control voltage determines the speed of rotation of the servo motor, and the phase controls the direction.

Rotation of the aileron servo motor produces feedback signals from the servo rate generator and from the aileron servo position follow-up synchro. The feedback signals from the rate generator, the position follow-up synchros, and the spoiler position transmitters are introduced into the servo loop of the amplifier-computer by transformers. The spoiler and servo follow-up signals are attenuated by a gain-setting potentiometer in the autopilot adapter. Figure 5 shows a block diagram of aileron control signals. Figure 6 shows a simplified schematic diagram of the aileron channel Signal Chain in the amplifier-computer, and shows how the control and feedback signals are introduced into the amplifier-computer.

(1) Plug-in Cards. Most of the servo loop components of the amplifier-computer consist of plug-in, card-mounted circuits that simplify maintenance and trouble shooting. The card amplifiers used transistors, crystal diodes, small-size transformers, and toroidal reactors. The cards are used as servo amplifiers, magnetic amplifiers, magnetic switches, limiters, and filters. Electromechanical computer cards and plug-in relays are also used. These plug-in units are easily removed and replaced.

(2) Aileron Channel Input Signals.

(a) Control Panel. Turn signals are introduced into the aileron signal chain by the control panel turn knob. The turn knob operates the wiper of a potentiometer that selects the phase and amplitude of a bank signal, which is transformer-coupled to the input of the bank angle limiter amplifier SA-71-A1. The output of the bank angle limiter feeds a signal into the aileron control signal chain. Part of the bank angle limiter output is fed to the rudder control signal chain for turn coordination in glide slope mode of operation.

(b) Remote Compass. Directional information from the remote compass is transformer-coupled to the input of the bank angle limiter amplifier for use in the manual mode of autopilot operation. Heading information is also fed to the input of the aileron integrator amplifier. The output of the integrator is mixed with the compass signal in the input to the bank angle limiter amplifier. Integration reinforces the compass signals and helps maintain an accurate flight path.

bandpass amplifier SA-78-A1 in the rudder channel servo loop. The crossfeed signal is used in turn coordination. When glide slope is engaged, a signal from the bank angle limiter in the aileron control channel is fed into the rudder control channel. This crossfeed signal, which is attenuated by a gain-setting potentiometer in the autopilot adapter, is used in turn coordination on ILS approach.

(3) Rudder Channel Output Signals. The rudder channel signals are applied to the input of servo amplifier SA-33-A1, and the output of the servo amplifier is applied to the input of magnetic amplifier SA-40-C1. The magnetic amplifier raises the control signal to a voltage level adequate to drive the rudder servc motor and position the rudder. The direction of rudder servo motor rotation is dependent upon the phase of the output voltage supplied by the amplifier. As the servo motor rotates it drives the servo rate generator and the rudder position follow-up synchro that feed signals back into the rudder channel servo loop.

The servo position follow-up synchro feedback signals null the rudder channel signals and bring the servo motor to a stop when the rudder surface reaches the required position. The rate generator feedback signals serve to damp oscillations of the servo motor.

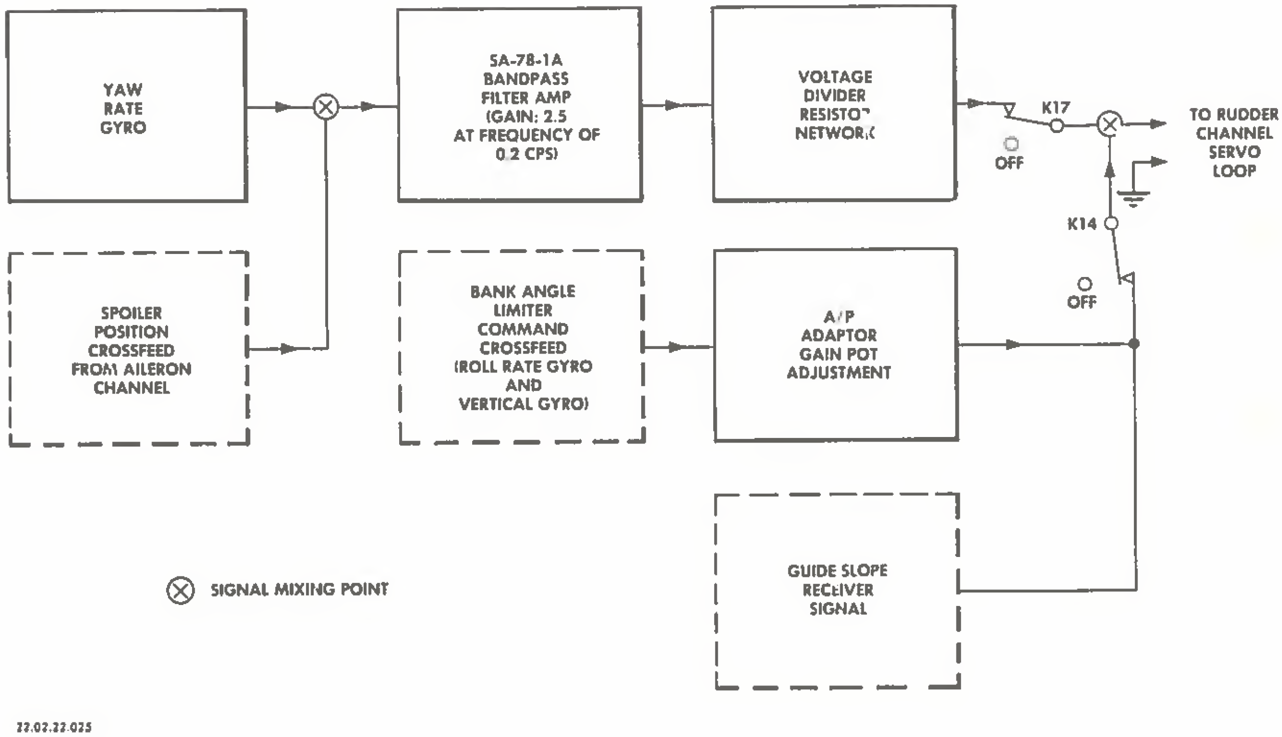
The torque limiting resistor limits the maximum torque that can be applied to the rudder cables.

An output circuit of SA-40-C1 magnetic amplifier drives the rudder trim indicator.

(4) Rudder Trim Indication. The rudder trim indicator is actuated by a voltage output of the SA-40-C1 magnetic amplifier. The indicator bar is displaced from center when the amplifier supplies output voltage. The amount of displacement is proportional to the amplitude of the output voltage; and the direction of displacement corresponds to the phase of the voltage which the amplifier supplies to the servo motor. Displacement of the indicator bar indicates that the airplane is out of trim and that the rudder control surface is holding an aerodynamic load.

E. Aileron Channel Operation.

Aileron channel control signals are fed into the autopilot amplifier-computer by the following: autopilot control panel, remote compass, VHF navigation radio receiver, course deviation indicator, roll rate gyro of the three-axis gyro unit, vertical gyro, and left and right inboard spoilers. These signals are combined and converted in the amplifier-computer, which develops control voltages of sufficient amplitude



Autopilot Rudder Control Signals, Block Diagram
Figure 3

D. Rudder Channel Operation.

Rudder channel control signals are fed into the autopilot amplifier-computer by the yaw rate gyro of the three-axis rate gyro, by crossfeed from the spoiler position transmitters in the aileron control channel, and by crossfeed from the roll rate and vertical gyros through the bank angle limiter amplifier in GS AUTO or GS MAN mode. The bank angle limiter signal is attenuated by a gain-setting potentiometer in the autopilot adapter. These signals are combined and converted in the amplifier-computer, which generates control voltages of sufficient amplitude to drive the servo that positions the rudder control tab.

Rotation of the rudder servo motor produces feedback signals from the rate generator and from the servo position transmitter synchro. These feedback signals are introduced into the servo control loop of the amplifier-computer by transformers, the position transmitter synchro signal being attenuated by a gain-setting potentiometer in the autopilot adapter. Figure 3 shows a block diagram of the rudder control signals. Figure 4 shows a simplified schematic of the rudder channel servo loop in the amplifier-computer, and shows how the control signals are introduced into the amplifier-computer.

(1) Plug-In Cards. Most of the servo loop components of the amplifier-computer consist of plug-in card-mounted circuits that simplify maintenance and trouble shooting. The card amplifiers use transistors, crystal diodes, small-size transformers, and toroidal reactors. The cards are used as servo amplifiers, magnetic amplifiers, magnetic switches, limiters, and filters. Relays are also mounted on plug-in cards. These plug-in units are easily removed and replaced.

(2) Rudder Channel Input Signals. The yaw rate signal from the three-axis rate gyro is applied to the SA-78-B1 amplifier, where it is demodulated and converted into a dc signal that varies as the rate signal amplitude varies. The signal is then passed through a bandpass filter that blocks high and low rate signals and passes only intermediate rate signals of about 0.2 cps. The output of the filter is superimposed on a 400 cps signal.

The modulated yaw rate signal is obtained only when the frequency of the yaw rate is about 0.2 cps. When the yaw rate frequency is high, or when the yaw rate frequency is low, the bandpass filter supplies approximately zero output. Steady-state yaw rate signals are washed out as a function of a time constant.

The crossfeed signal from the spoiler position transmitters in the aileron channel servo loop is mixed with the yaw rate signal to the

(3) LOC-VOR. In this mode the airplane will follow a VOR radial or a localizer path by combining compass headings and omnirange radio signals. The airplane, under the guidance of the autopilot, intercepts the radial or localizer beam at a set angle and turns smoothly into the selected course. The pilots set the magnetic bearing of the desired radial or of the inbound runway into the course deviation indicator. After interception, the autopilot automatically steers the airplane along the radial or localizer beam.

(4) GS AUTO. For this mode the radio receiver is tuned to the ILS frequency of the station and the inbound bearing of the runway is set into the course deviation indicator. The glide slope armed light illuminates when the selection is made and remains illuminated until the airplane glide slope receiver intercepts the glide slope beam. At interception, the light extinguishes and the glide slope automatically engages. The autopilot then guides the airplane along the localizer and glide slope beams.

(5) GS MAN. This mode is the same as GS AUTO except that the pilot engages the glide slope manually before intercept. The airplane then ascends or descends automatically to intercept the glide slope beam.

B. Yaw Damper Operation

The yaw damper system augments airplane stability in yaw during manual control by placing the rudder under automatic control. Ailerons and elevator are not affected. Either pilot can overpower the automatic rudder for turn maneuvering. The yaw damper system is engaged by actuating the autopilot-damper weitch to DAMPER position. The yaw damper system can be disengaged by depressing the autopilot disengage switch on either pilot's control wheel or actuating the autopilot-damper switch on the control panel to OFF position.

C. Altitude Control Operation.

After the autopilot engages, pilots may select automatic control of altitude by actuating the altitude control switch to ALT position. The autopilot then maintains the altitude at which the altitude switch was engaged. If the altitude switch is engaged while the airplane is in a climb or dive, the airplane levels off, returns to, and holds the altitude it had when the altitude switch was actuated. The altitude switch is spring-loaded to disengaged position. When the autopilot disengages or electrical power is disconnected, the switch automatically returns to off position. The autopilot altitude hold switch will not engage if the altitude hold switch in the flight director system is in ALT position.

selected heading, flies a selected omnirange radial or localizer beam, or descends along a glide slope path in accordance with the flight mode selected. If the altitude selector on the controller is engaged, the autopilot automatically maintains the selected altitude. When flying a compass heading with a HDG mode selection, small changes in heading are made by changing the preset heading set into the course deviation indicator on the instrument panel. Turn maneuvers in MAN mode are made by actuating the turn control knob on the autopilot controller. The pitch control wheels on the autopilot controller establish the pitch attitude reference, if the altitude switch is not engaged or GS AUTO mode is not selected.

The autopilot disengages when the autopilot disengage switch on either control wheel is depressed or when the autopilot-damper switch on the controller is actuated to OFF position. When the autopilot disengages, the mode selector switch automatically returns to MAN position, the autopilot-damper switch returns to OFF position, and the altitude engage switch disengages.

The mode selector switch of the flight director system is grounded through the autopilot disengage switches on the control wheels. When either switch is actuated to disengage the autopilot system, the flight director mode selector switch also disengages.

The autopilot-disengaged warning light illuminates on the instrument panel if a malfunction occurs or if the autopilot-damper switch on the control panel is manually actuated to OFF position. The warning light can be extinguished by depressing the disengage switch on either control wheel.

Selection by the 5-position mode selector switch on the autopilot control panel determines the manner in which the autopilot controls the airplane in flight. The autopilot must be engaged before making a selection on the mode selector switch. A description of the modes of autopilot operation follows.

(1) MAN. When the autopilot is engaged and the mode selector switch is in MAN position, the system uses a compass reference. This mode is called a clutched heading mode because the autopilot is clutched or engaged to the remote compass. The mode selector switch automatically returns to MAN position from any other mode selection when the autopilot disengages. In MAN mode the airplane is gyro stabilized in pitch, roll and yaw; and an altitude reference is provided if the ALT switch on the control panel is engaged.

(2) HDG. In HDG mode the autopilot steers the airplane to the heading selected by the heading knob on the course deviation indicator. Small changes in heading are made by changing the heading selection. The autopilot turns the airplane smoothly to the selected heading or to a new heading when the preset heading is changed.

For safety of operation the electrical power circuits of the autopilot are interlocked with the electrical power systems of the airplane. The autopilot will not engage if any of the interlock requirements are not satisfied, and will disengage if the interlocks open.

The autopilot uses 3-phase ac power from the electrical system of the airplane. All the dc power needed for operation of the autopilot is obtained by rectifying and filtering ac.

The PB-20G autopilot requires no heating time, but the gyros require about two minutes for erection and readiness to operate after power is turned on. If the autopilot fails to engage after two minutes, the operator should make sure that the turn control knob on the autopilot control panel is in center detent position and should again attempt to engage.

A. Power Requirements.

The autopilot system uses 3-phase, 115/200-volt ac power from the Y-connected, grounded-neutral, electrical system of the airplane through the No. 3 essential ac bus. Dc power required for the autopilot system is obtained by rectifying ac within the system. Power dissipation of the autopilot system is approximately 1500 volt-amperes for steady-state operation.

Single-phase power for the vertical gyro is taken from the No. 3 ac essential bus. If No. 3 ac essential bus fails, the vertical gyro is transferred to the pilots' ac essential bus. Warning light and warning light control power is taken from the 28-volt dc emergency bus.

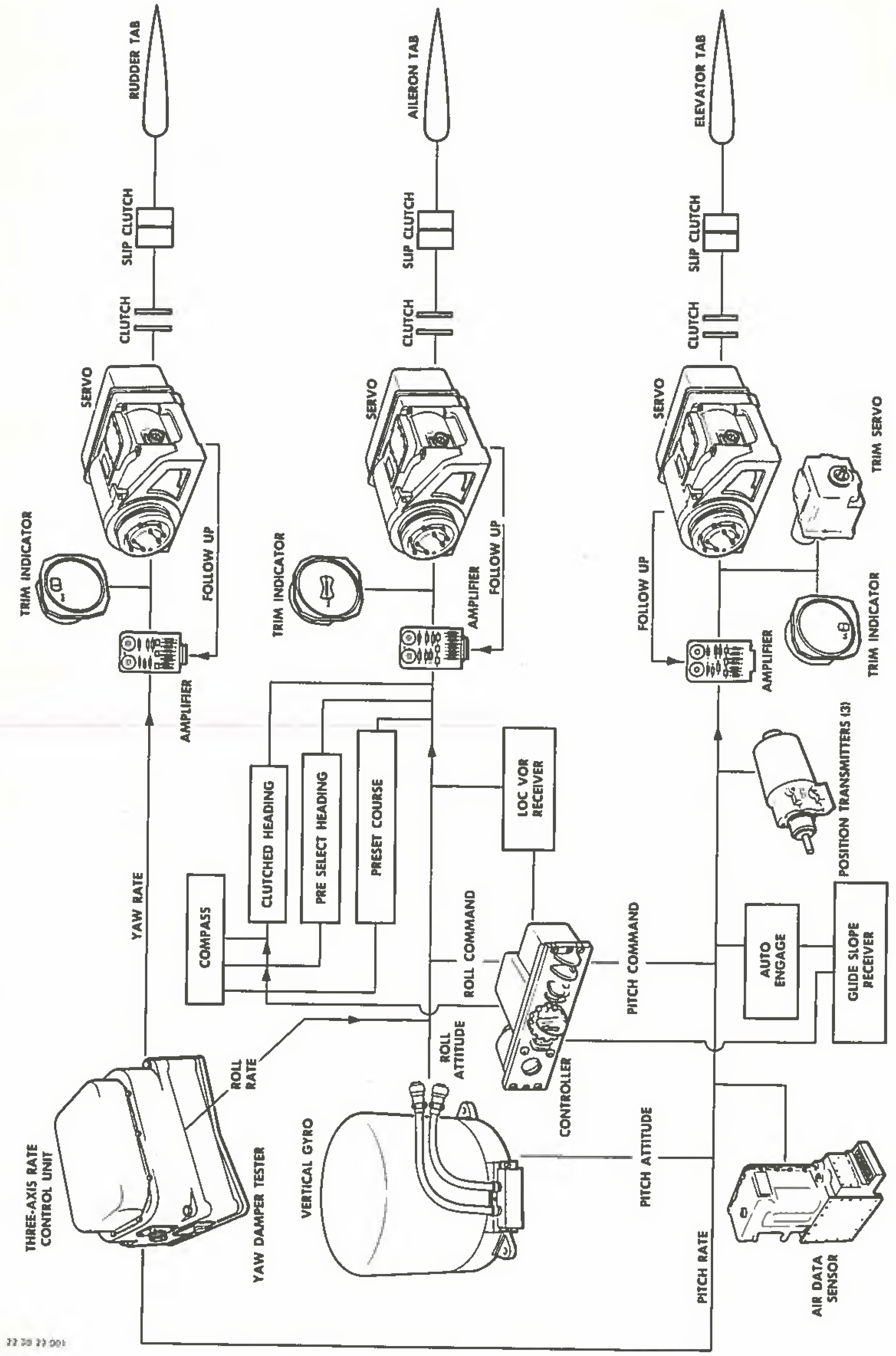
B. Circuit Protection.

A 5-ampere circuit breaker protects each phase of the 3-phase electrical power supply system and the autopilot system. A 3-ampere circuit breaker protects the single-phase supply system and the vertical gyro. A 10-ampere fuse protects the 28-volt supply system and the warning light system. These circuit breakers are located on the main circuit breaker panel.

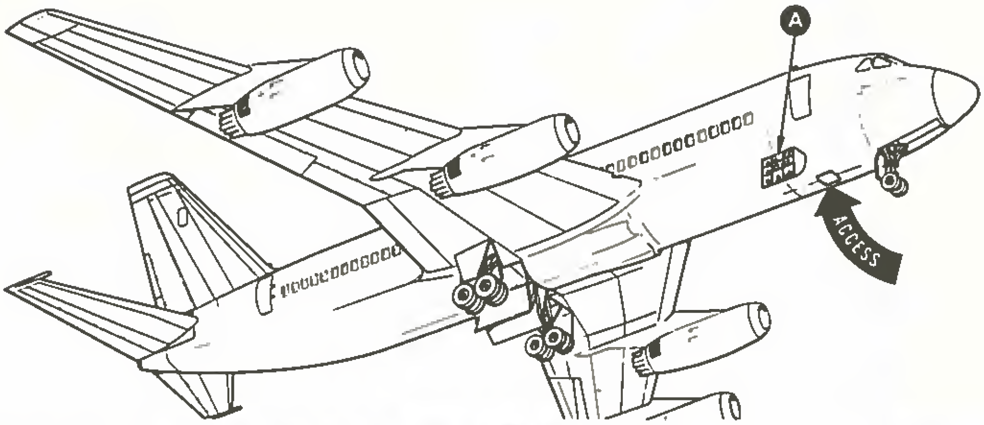
2. Autopilot System Operation

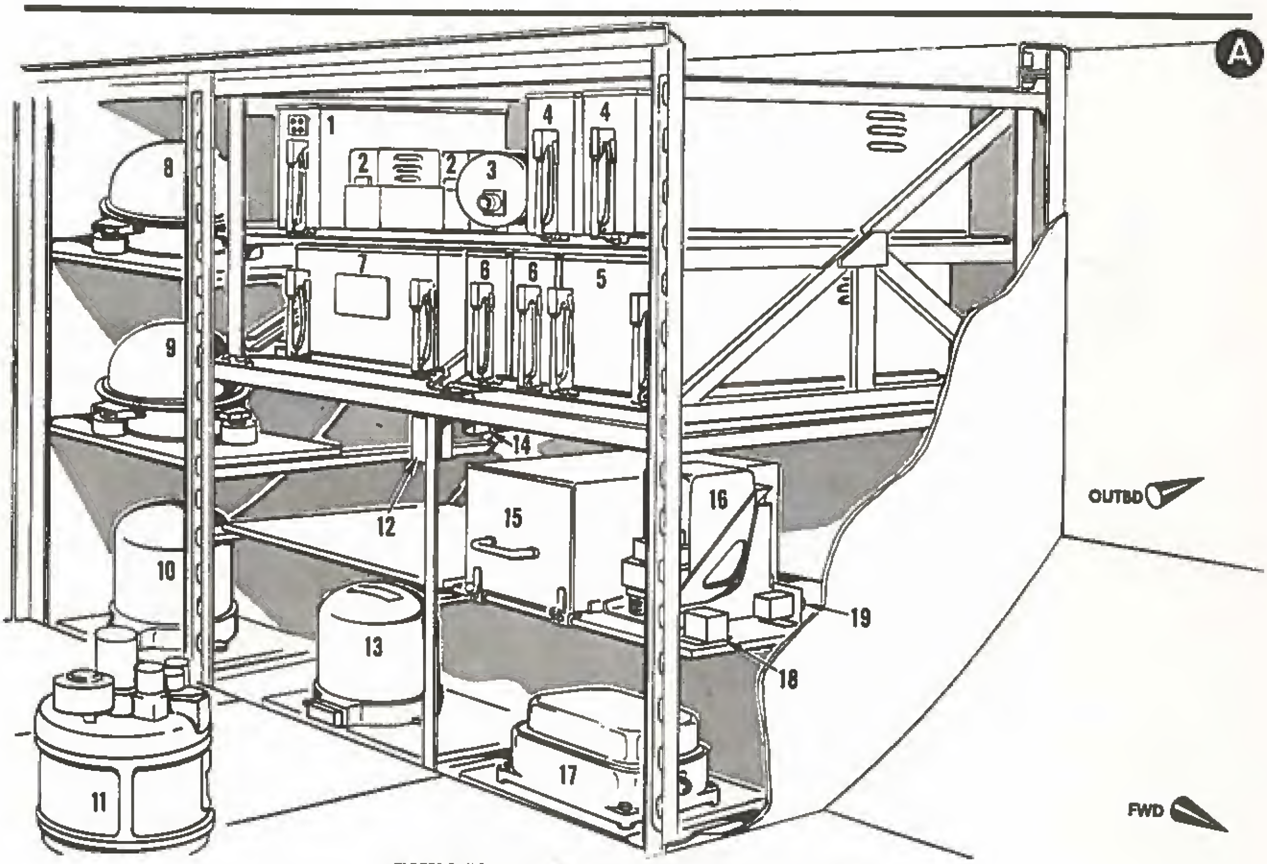
A. Autopilot Operation.

The autopilot system engages after a 0.5 second delay when the autopilot damper selector switch is actuated to AUTOPILOT position. Befor attempting to engage the autopilot system, the operator should make sure that the trim indicator bars are centered and that the turn knob is in center detent position. The pitch control wheels can be in any position at engagement. The autopilot automatically maintains a



Autopilot System, Diagram
Figure 2





ELECTRONIC EQUIPMENT RACK IN ELECTRICAL COMPARTMENT
(HINGED DOORS REMOVED FOR CLARITY)
VIEW LOOKING AFT—LEFT-HAND ELECTRICAL COMPARTMENT RACKS

1. AUTOPILOT POWER JUNCTION BOX.
2. PILOT'S AND COPILOT'S RMI SERVO AMPLIFIERS.
3. COMPASS COMPARATOR (REMOTE COMPASS SYSTEM).
4. PILOT'S AND COPILOT'S COMPASS COUPLERS (REMOTE COMPASS SYSTEM).
5. FLIGHT STEERING COMPUTER (FLIGHT DIRECTOR SYSTEM).
6. PILOT'S AND COPILOT'S FLIGHT INSTRUMENT AMPLIFIERS (FLIGHT DIRECTOR SYSTEM).
7. AUTOPILOT AMPLIFIER-COMPUTER.
8. PILOT'S DIRECTIONAL GYRO.
9. COPILOT'S DIRECTIONAL GYRO.
10. VERTICAL GYRO NO. 2.
11. CABIN PRESSURE REGULATING AND RELIEF VALVE.
12. AUTOPILOT ADAPTER.
13. VERTICAL GYRO NO. 1.
14. PILOT'S AND COPILOT'S COMPASS POWER FAIL DETECTORS (REMOTE COMPASS SYSTEM).
15. CONTROL CHASSIS ASSEMBLY (KIFIS).
16. AUTOPILOT AIR DATA SENSOR AND SHOCK MOUNT.
17. 3-AXIS RATE CONTROL (AUTOPILOT).
18. TRIM WARNING TIME-DELAY RELAY.
19. FLAP POSITION RELAY.

22.30.34.047B

Electrical Compartment Racks
Figure 1

signals is thus modified to attain smooth control at all altitudes and airspeeds.

Integration compensates for small persistent deviations from the reference flight path. Deviations, such as those caused by cross winds or loading changes, may be too small to directly actuate the autopilot system. Integration builds up the small error signals to a magnitude sufficient to return the airplane to the reference flight path.

After the autopilot engages in autopilot or damper mode, a time delay relay with the time constant of 0.5 second delays the introduction of yaw rate signals into the rudder channel signal chain. This delay ensures the engagement of the servo electromagnetic clutch before any error signal is applied to the servo motor. Without the time delay the servo motor could be running and a transient result when the clutch engages.

The autopilot receives input signals from the remote compass system, from omni-range stations, from ILS stations, from altitude and airspeed sensors, from gyros, from spoiler position transmitters, and from servo transmitters. The autopilot system's amplifier-computer unit combines the signals and converts them for automatic control of the airplane in flight. Figure 1 shows the location of components that comprise the PB-20G autopilot system and Figure 2 shows a functional diagram of the system.

The PB-20G autopilot provides complete automatic control of the airplane in the pitch, yaw, and roll axes, and yaw stability augmentation under manual control. Using radio signals from the VHF navigation systems, the autopilot smoothly steers the airplane into and along preselected omnistation radials. Using signals from the ILS receivers, the autopilot guides the airplane so that it intercepts localizer and glide slope beams, and then controls descent to the runway. Remote compass signals enable the autopilot to fly a magnetic bearing course preselected by the pilots on the course deviation indicator. Altitude control enables the autopilot to maintain a selected altitude.

Indicator lights warn and inform pilots of flight situations and autopilot disengagement. The autopilot control panel selector switches are spring-loaded and solenoid held. If electrical power is cut off or if the autopilot becomes disengaged, the selector switches automatically return to OFF and MANUAL positions; and pilots must resume manual control of the airplane until the autopilot is reengaged.

Modular construction is used in the amplifier-computer unit. Plug-in magnetic amplifiers and plug-in transistorized amplifiers make repair and maintenance easy and rapid. Plug-in card amplifiers are indexed to prevent errors while installing and to facilitate adaptation of units to other systems.

CHAPTER 22

AUTOPILOT SYSTEM - DESCRIPTION AND OPERATION

1. General

The autopilot system provides coordinated control in all three axes of the airplane and maintains attitude, altitude, and preset heading within the following limits of deviation from a reference flight path:

Pitch	±1 degree
Altitude	
At sea level	±50 feet
At 40,000 feet	±100 feet
At sea level, during turns	±50 feet
At 40,000 feet, during turns	±200 feet
Compass heading	±1 degree
Bank angle	
MAN mode	±40 degrees
HDG mode	±40 degrees
LOC-VOR mode	±30 degrees
GS MAN or GS AUTO mode	
At engagement	±30 degrees
After 60 second delay	±18 degrees

When the airplane changes from a reference flight path, error signals proportional to the rate of change are generated. The amplitude of error signals is greatest as the airplane starts to change attitude or direction, and a large corrective signal is quickly introduced.

This rate signal develops control forces that oppose the change. As the control forces take hold, the rate signal decreases until it becomes zero. At this point control forces are developed by a signal proportional to the positional error. These forces tend to return the airplane to its reference flight path. During this return, a signal generated by the rate of return is used as a damping function to ensure a smooth recovery.

Autopilot signals for aileron and elevator control are attenuated by potentiometers in the air data sensor before the control signals are applied to the surface servos. The potentiometer wiper contacts are positioned by altitude and airspeed sensors. The amplitude of control

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Chapter 22
AUTOPILOT

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LIST OF EFFECTIVE PAGES

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22	2	May 25/61	B-3
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22-0	2	Sep. 20/60	B-4
22-0	3	Sep. 20/60	B-4
22-0	4	Basic	A
22-0	5	Basic	A
22-0	6	Sep. 20/60	B-4
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22-0	8	Apr. 28/60	B-2
22-0	9	Basic	A
22-0	10	Apr. 28/60	B-2
22-0	11	May 25/61	B-3
	BLANK		
22-0	13	Apr. 28/60	B-2
22-0	14	Basic	A
	BLANK		
22-0	16	Apr. 28/60	B-2
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22-0	19	Apr. 28/60	B-2
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22-0	27	Apr. 28/60	B-2
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22-0	37	Apr. 28/60	B-2
22-0	38	Sep. 20/60	B-4
22-0	39	Sep. 20/60	B-4
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22-0	103	Sep. 20/60	B-4
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	BLANK		
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22-0	113A	Feb. 18/60	A-1
	BLANK		
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22-0	116	Basic	A
22-0	117	Basic	A
22-0	118	Basic	A
22-0	119	Basic	A
22-0	120	Basic	A
22-0	121	Basic	A
22-0	122	Basic	A
22-0	123	Basic	A
22-0	124	Basic	A
22-0	125	Basic	A
22-0	126	Basic	A
22-0	501	May 25/61	B-3
22-0	502	May 25/61	B-3
22-0	503	May 25/61	B-3
22-0	504	May 25/61	B-3
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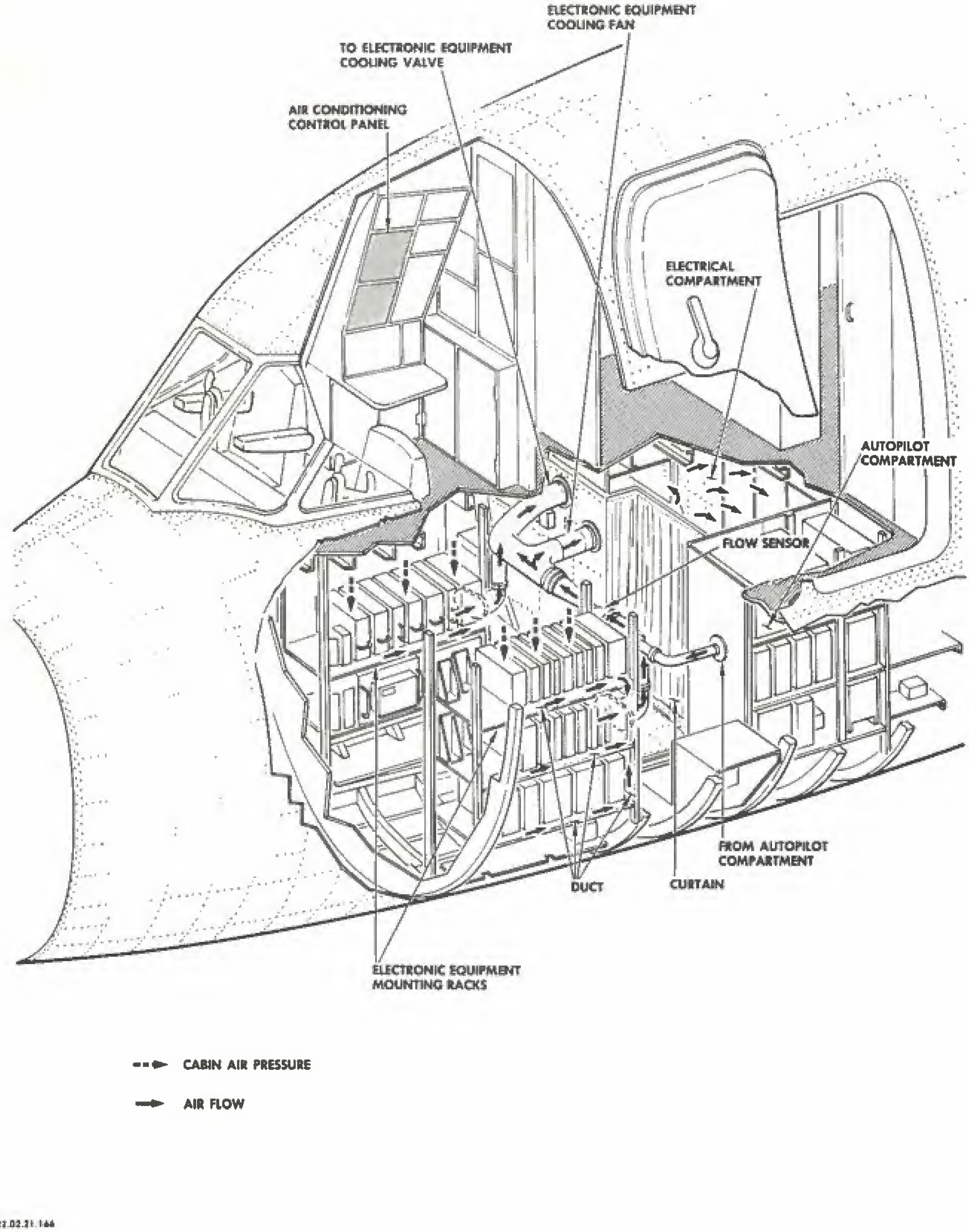
22-0	513	May 25/61	B
22-0	514	May 25/61	B
22-0	515	May 25/61	B
22-0	516	May 25/61	B
22-0	517	May 25/61	B
22-0	518	May 25/61	B
22-1-0	1	Sep. 20/60	B-4
22-1-0	2	Basic	A

For normal operation of the electronic equipment cooling subsystem, the electronic equipment cooling valve is left in the open position. It is not necessary to close the valve unless a malfunction in the pressurization system requires it. The electronic equipment cooling fan is automatically operated on the ground by a ground safety relay, and the fan is turned on manually in flight when the LOW AIR FLOW warning light illuminates.



Electronic Equipment Cooling Ducts
Figure 1

ELECTRONIC EQUIPMENT COOLING DUCTS - DESCRIPTION AND OPERATION

1. Description

The electronic equipment cooling ducts consist of a series of ducts built into the electronic equipment mounting racks, and the connecting ducts which route the air through the cooling fan, the electrical compartment, and then overboard. See Figure 1.

Cooling air passes downward through each component on the electronic equipment racks. It then enters the ducts built into the racks, and is routed aft and up to the roof of the compartment. Cooling air exhausted from the left racks is routed through a flow sensor (venturi tube) to the right side of the compartment. It then passes through a check valve and is dumped overboard through the electronic equipment cooling valve. Cooling air exhausted from the right racks is routed aft through the mounting racks and up toward the roof of the compartment. It then passes through the same check valve and electronic equipment cooling valve to be dumped overboard. Air from the right electronic equipment cooling rack does not pass through the flow sensor.

The autopilot compartment is physically located on the left side of the electrical compartment. Since it is closed off from the electrical compartment, we can consider it a separate area for discussing cooling air flow patterns. Cooling of autopilot components is accomplished by the general circulation of air through the area. It does not route air under pressure through the components. The cooling air moves forward through the compartment and is then ducted through the flow sensor where it follows the same path as air exhausted from the left electronic equipment racks.

In the electrical compartment two separate flow patterns are used. The pattern depends upon whether ventilation is being provided by cabin pressure, or by the electronic equipment cooling fan. When the airplane is pressurized and the cooling fan is turned off, air enters the compartment through large flapper-type check valves mounted in the walls. It then cools the components by circulating through the compartment, and is normally dumped overboard through the electronic equipment cooling valve. If the cabin pressurization schedule requires it, or if the aft pressure regulating outflow valve should malfunction toward the closed position, additional air will be dumped overboard through the forward pressure regulating outflow valve. If necessary, the electrical compartment check valves and the forward pressure regulating outflow valve can handle the entire output of the pressurization system to maintain normal pressurization schedules. When the electronic equipment cooling fan is operating, it pulls air through both electronic equipment racks and the autopilot compartment, and forces the air into the electrical compartment. The air is then dumped overboard through the forward pressure regulating outflow valve.

ELECTRONIC EQUIPMENT COOLING VALVE - DESCRIPTION AND OPERATION

1. Description

The electronic equipment cooling valve consists of a short duct section containing a butterfly valve, and an actuator housing containing a reversible 28-volt dc motor and two limit switches. The valve is installed on the right hand side of the electrical compartment to provide an additional flow of cooling air during normal operations, and to insure an adequate flow if the forward pressure regulating outflow valve fails to the closed position. Since the airflow past the cabin and flight deck temperature sensors (thermal resistors) is also routed to the electrical compartment, the cooling valve also improves the reliability of the automatic temperature control system.

2. Operation

The electronic equipment cooling valve is controlled by the ELECT EQUIP COOLING VALVE switch on the flight engineer's panel. Placing the switch in the OPEN position will apply 28-volts dc to drive the actuator motor to the full open position. When the open position is reached, a limit switch within the actuator housing will interrupt the electrical power. Placing the control switch in the CLOSED position will, in a similar manner, apply power to drive the valve to the closed position. Another limit switch will interrupt power at the closed position. The electronic equipment cooling valve cannot be stopped in an intermediate position.

Normally the electronic equipment cooling valve is left in the open position. It is not necessary to close the valve except when necessary to maintain cabin pressure in an emergency, or to prevent the entry of water during a ditching procedure. The valve must also be closed when the electronic equipment cooling fan is turned on during periods of inadequate cooling from normal pressurization airflow.

2. Adjustment/Test

A. Equipment Required

(1) An electrical power source. It may be a ground cart or one of the engine driven generators.

B. Preparation.

(1) When the electrical buses are energized, a ground safety relay will normally operate the electronic equipment cooling fan and the LOW AIR FLOW warning light will not be illuminated. If the LOW AIR FLOW light is illuminated, trouble shoot the system.

(2) With the LOW AIR FLOW warning light not illuminated, open the ELEC COMPT FAN CONT circuit breaker. The warning light shall illuminate. Close the circuit breaker and the warning light shall extinguish.

CAUTION: DO NOT LEAVE THE ELEC COMPT FAN CONT CIRCUIT BREAKER OPEN LONGER THAN NECESSARY TO COMPLETE THE TEST. OVERHEATING MAY OCCUR IN THE ELECTRICAL AND ELECTRONIC EQUIPMENT.

COOLING AIR FLOW SENSOR - MAINTENANCE PRACTICES

1. Removal/Installation Cooling Air Flow Sensor (refer to 21-9-1, Figure 1)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open CABIN ALT WARN LT circuit breaker. Place warning tag on open circuit breaker.

      (2) Open electrical and electronic compartment access door.

   C. Remove Cooling Air Flow Sensor.

      (1) Locate the cooling air flow sensor. It is a venturi shaped duct section with a pressure switch mounted on top. The flow sensor runs across the compartment near the roof, and directly over the aft edge of the door.

      (2) Disconnect electrical connector from aft end of pressure switch. (Cap connector and receptacle. Tag connector for installation.)

      (3) Disconnect grounding wire attached to overhead structure and air flow sensor.

      (4) Remove wire securing each end of flow sensor to adjoining duct.

      (5) Remove cooling air flow sensor.

   D. Install Cooling Air Flow Sensor.

      (1) With electrical receptacle on top and pointing aft, position flow sensor between duct openings.

      (2) Position connecting hose on each end of flow sensor. Secure in place with two turns of wire. Twist approximately one inch of the wire ends together to secure in place.

      (3) Connect grounding wire to overhead structure.

      (4) Connect electrical connector to pressure switch on flow sensor.

      (5) Close electrical and electronic equipment compartment door.

      (6) Remove warning tag and close CABIN ALT WARN LT circuit breaker.

      (7) Perform Adjustment/Test.

COOLING AIR FLOW SENSOR - DESCRIPTION AND OPERATION

1. Description

The cooling air flow sensor, shown in 21-9-1, Figure 1, consists essentially of a pressure switch mounted on a venturi-type duct. The pressure switch assembly is divided into two chambers by a diaphragm. A low pressure chamber on one side of the diaphragm is connected to a pressure tap at the smallest diameter of the venturi-type duct. A calibration screw and plate compress a calibration spring against the low pressure side of the diaphragm. A high pressure chamber on the other side of the diaphragm is connected to a pressure tap at the duct inlet. A limit switch is mounted in this chamber and contacts the diaphragm so that, at no airflow, the switch is closed.

2. Operation

In operation cooling air is routed through the venturi-type duct. Air pressure at the duct inlet acts on the high pressure side of the diaphragm, while air pressure at the duct throat acts on the low pressure side. Since air pressure at the duct throat is lower than inlet pressure, a pressure differential is formed across the diaphragm.

When inlet airflow conditions cause a pressure differential that is sufficient to move the diaphragm from the limit switch, the circuit is opened between pins A and B. A decrease in airflow (to below the circuit closing range) results in a decrease in pressure differential, causing the diaphragm to contact the limit switch and close the circuit. The circuit will remain closed while inlet airflow conditions are below the calibrated range.

(a) Electronic equipment cooling fan shall start.

(b) LOW AIR FLOW WARNING light shall extinguish.

(2) Place ELECT EQUIP COOLING FAN switch in OFF position and note the following:

(a) Electronic equipment cooling fan shall stop.

(b) LOW AIR FLOW warning light shall illuminate.

(3) Place RH landing gear ground safety switch in "ground" position and note the following:

(a) Electronic equipment cooling fan shall start.

(b) LOW AIR FLOW WARNING light shall extinguish.

<u>NOTE</u>: With the airplane in the "groundborne" configuration the fan shall operate with the ELECT EQUIP COOLING FAN switch in either the ON or OFF position.

(4) Open ELEC COMPT FAN CONT circuit breaker and note the following:

(a) Electronic equipment cooling fan shall stop.

(b) LOW AIR FLOW WARNING light shall illuminate.

(5) Open CABIN ALT WARN LT circuit breaker; the LOW AIR FLOW WARNING light shall extinguish.

(6) When test is satisfactory, remove external electrical power and restore airplane to normal configuration.

(6) Install three 5A ELECT COMPT BLOWER fuses in the ac power distribution panel.

(7) Remove warning tag and close ELEC COMPT FAN CONT circuit breaker.

(8) Operate fan and feel for air discharged from aft end.

(9) Perform Adjustment/Test of fan.

2. Adjustment/Test Electronic Equipment Cooling Fan

A. Equipment Required.

External source of 115/200-volt, 3-phase, 400 cycle ac electrical power (refer to Chapter 24, ELECTRICAL POWER).

B. Preparation.

CAUTION: IN STEP (1) FOLLOWING, DO NOT OPEN THE AC POWER DISTRIBUTION PANEL WITH THE BATTERY ON, THE ENGINES RUNNING, OR WITH EXTERNAL POWER CONNECTED TO THE AIRPLANE.

(1) Ascertain that three 5A ELECT COMPT BLOWER fuses are installed in the ac power distribution box.

(2) Connect external source of electrical power to airplane (refer to Chapter 24, ELECTRICAL POWER).

WARNING: PRIOR TO PERFORMING STEP (3) FOLLOWING, ASCERTAIN THAT ANTISKID SYSTEM IS TURNED OFF AND/OR THE MAIN WHEELS ARE PROPERLY CHOCKED.

(3) Place RH landing gear ground safety switch in "airborne" position.

(4) Close the following circuit breakers:

(a) CABIN ALT WARN LT.

NOTE: When the CABIN ALT WARN LT circuit breaker is closed, the LOW AIR FLOW warning light on the flight engineer's air conditioning and pressurization control panel shall illuminate.

(b) ELEC COMPT FAN CONT.

(c) RH LDG GEAR GRD SAFETY SW.

(5) Close electrical and electronic equipment access door.

C. Test Electronic Equipment Cooling Fan.

(1) Place ELECT EQUIP COOLING FAN switch in ON position and note the following:

ELECTRONIC EQUIPMENT COOLING FAN - MAINTENANCE PRACTICES

1. Removal/Installation Electronic Equipment Cooling Fan

   A. Equipment Required - None

   B. Preparation.

      (1) Open ELEC COMPT FAN CONT circuit breaker. Place warning tag on open circuit breaker.

      CAUTION: IN STEP (2) FOLLOWING, DO NOT OPEN THE AC POWER DISTRIBUTION PANEL WITH THE BATTERY ON, THE ENGINES RUNNING, OR WITH EXTERNAL POWER CONNECTED TO THE AIRPLANE.

      (2) Remove three ELECT COMPT BLOWER fuses from the ac power distribution panel. (Bag and Tag for installation.)

      (3) Open the electrical and electronic compartment door.

   C. Remove Electronic Equipment Cooling Fan.

      (1) Locate fan mounted near the roof of the compartment slightly to the right of the airplane centerline and slightly aft of the door. The fan housing forms a duct section running aft from the electronic equipment racks to the forward right hand bulkhead of the electrical compartment.

      (2) Remove wire securing ducts to forward and aft end of fan housing.

      (3) Disconnect electrical connector from fan. (Cap connector and receptacle. Tag for installation.)

      (4) Disconnect grounding wire from fan.

      (5) While supporting fan, remove four bolts securing fan to overhead structure. (Bag and tag hardware for installation.)

      (6) Remove electronic equipment cooling fan.

   D. Install Electronic Equipment Cooling Fan.

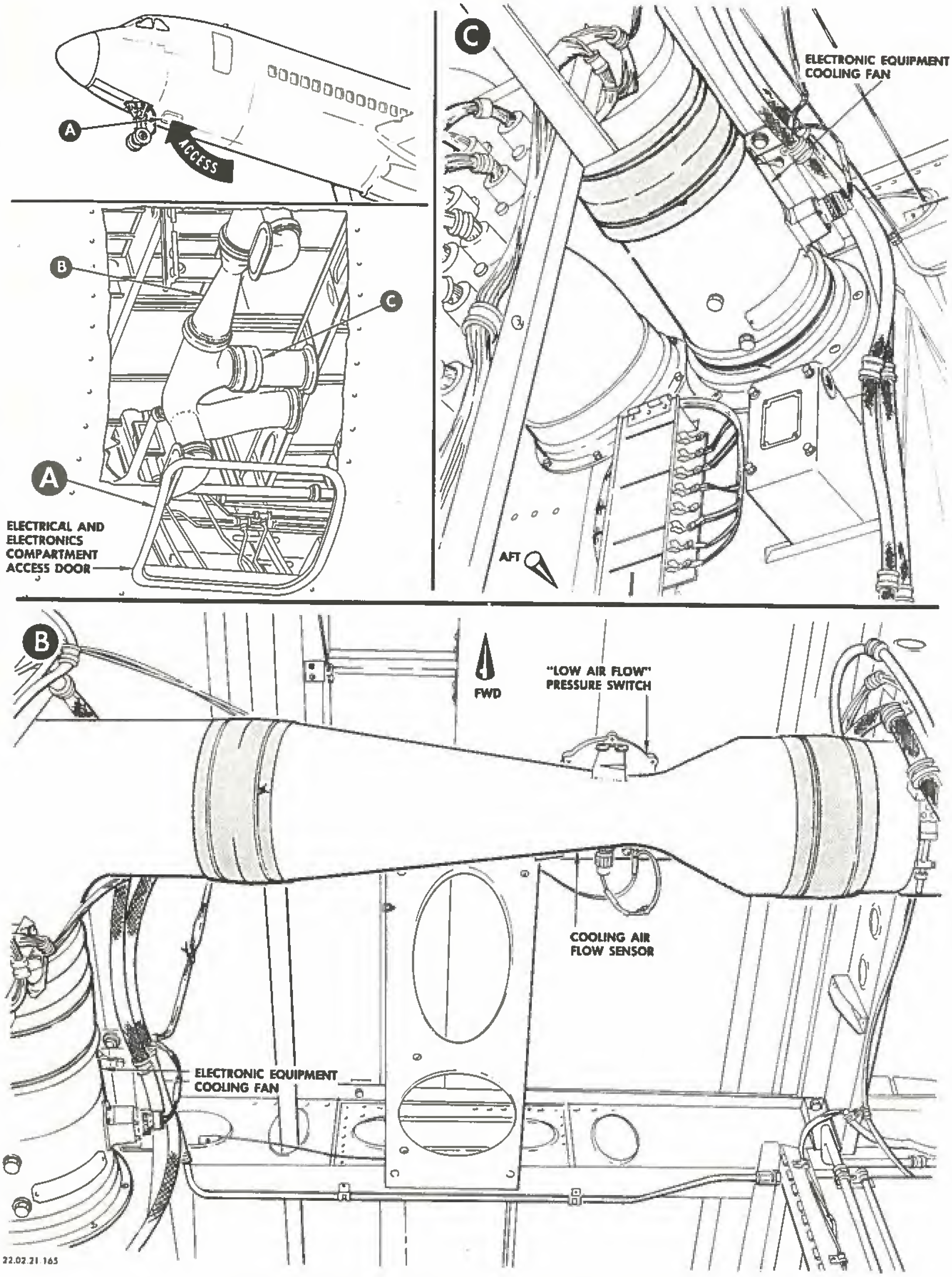
      (1) Position fan between duct openings with the direction of flow arrow pointing aft.

      (2) Install four mounting bolts to secure fan to overhead structure.

      (3) Connect grounding wire to fan.

      (4) Connect electrical connector to fan receptacle.

      (5) Secure ducts at forward and aft ends of fan housing with wire.



Electronic Equipment Cooling Fan and Air Flow Sensor
Figure 1

ELECTRONIC EQUIPMENT COOLING FAN - DESCRIPTION AND OPERATION

1. Description

The electrical equipment cooling fan consists of a fan housing, the fan, and the fan motor. See Figure 1. The fan housing consists of a 6.00 inch inside diameter duct section approximately 9.50 inches long. The fan and fan motor are installed inside of the fan housing. The fan motor is a 115/200-volt, 3-phase, 400 cycle ac motor incorporating automatic three phase thermal overload protection.

The fan capacity is 35 pounds per minute weight flow at 3.65 inches of water static pressure differential across the fan at sea level pressure and 130 degree F inlet air temperature.

2. Operation

The electronic equipment cooling fan has provisions for both automatic and manual operation. Automatic operation is controlled by the right hand ground safety relay no. 4. This relay turns the fan on at all times when the airplane is on the ground. Manual operation is available through a switch on the flight engineer's panel. The switch should be placed ON when the LOW AIR FLOW warning light is illuminated. If it should become necessary to depressurize the airplane in flight, or if the cabin pressure differential is too low for adequate cooling, the LOW AIR FLOW warning light will remind the flight engineer to operate the cooling fan.

POSSIBLE CAUSES	ISOLATION PROCEDURE AND CORRECTION
	and dimming relay to the LOW AIR FLOW warning light.
C. Faulty flow sensor.	With no cooling air flow, check for continuity between pins A and B of the flow sensor. If no continuity replace flow sensor.

5. LOW AIR FLOW WARNING LIGHT REMAINS ON

A. Faulty flow sensor.	If air flow appears normal, replace flow sensor. Visually check ducts for obstruction.

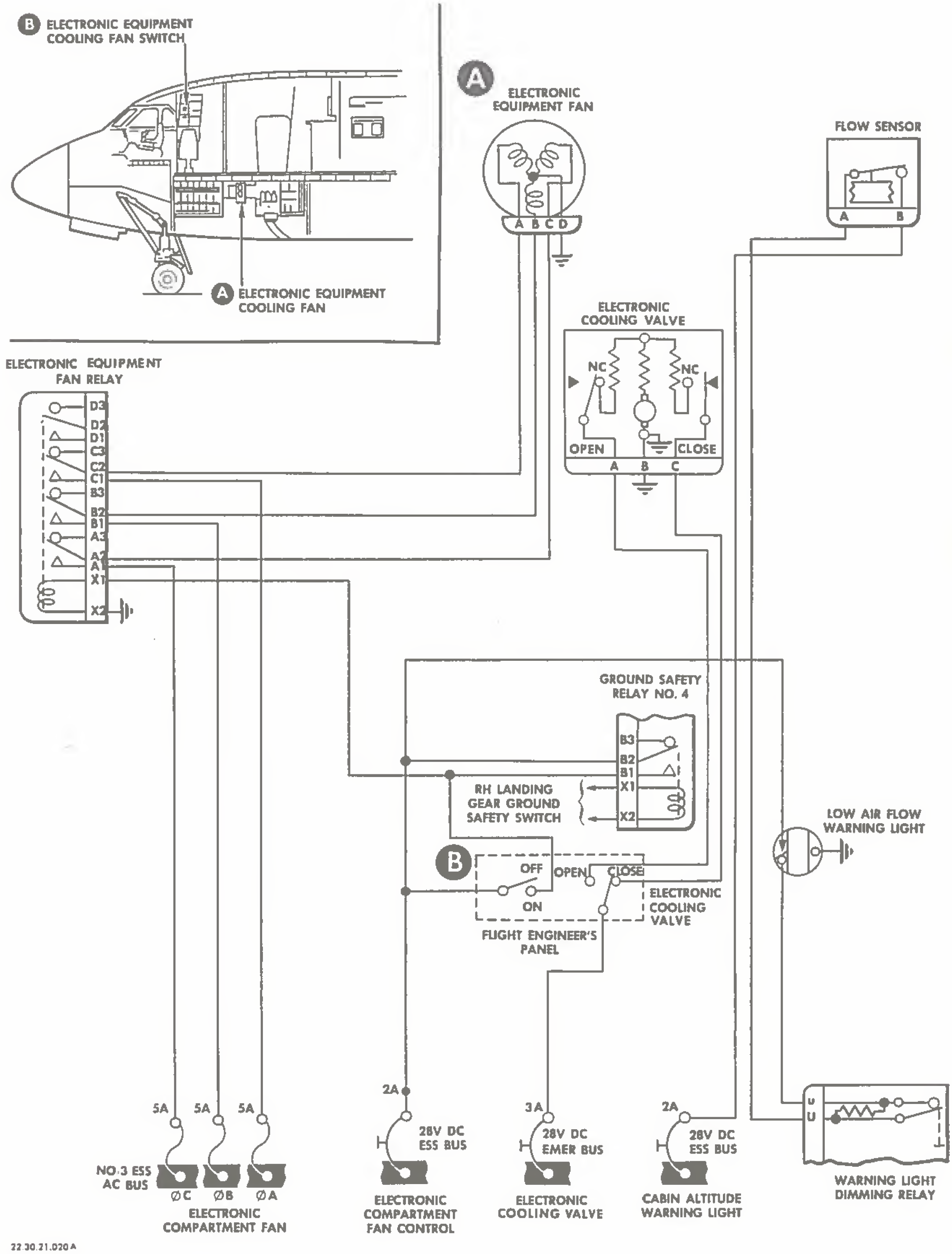
ELECTRONIC EQUIPMENT COOLING SUBSYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSES	ISOLATION PROCEDURE AND CORRECTION
1. ELECTRONIC EQUIPMENT COOLING FAN INOPERATIVE	
A. Faulty fuses or circuit breaker.	Check three 5 ampere ELECT COMPT BLOWER fuses in ac power distribution panel (flight engineer's station).
	Check ELEC COMPT FAN CONT circuit breaker on main circuit breaker panel.
B. Faulty cooling fan.	Remove electrical connector from fan. Place ELECT EQUIP COOLING FAN switch ON. Check for 115 volts ac between terminal A and ground, terminal B and ground, and terminal C and ground. If proper voltages and the ground connections exist at connector, replace the cooling fan.
C, Faulty wiring or fan control relay.	If proper voltage does not exist at fan connector, check wiring from connector through fan control relay to fuses in ac power distribution panel.
2. NO AUTOMATIC OPERATION BY GROUND SAFETY RELAY (MANUAL OPERATION OK)	
A. Faulty ground safety relay operation.	Check operation of RH ground safety switch and RH ground safety relay No. 4 (refer to Chapter 32, LANDING GEAR).
	Check wiring from ELEC COMPT FAN CONT circuit breaker through RH ground safety relay No. 4 to the electronic compartment fan control relay.
3. NO MANUAL OPERATION (AUTOMATIC OPERATION BY GROUND SAFETY RELAY OK)	
A. Faulty electronic compartment cooling fan switch, or faulty wiring	Remove the RH ground safety relay No. 4 from socket and check for continuity from the ELEC COMPT FAN CONT circuit breaker through the fan control switch to the fan relay.
4. LOW AIR FLOW WARNING LIGHT INOPERATIVE	
A. Faulty warning light bulb or circuit breaker.	Test bulb and check CABIN ALT WARN LT circuit breaker.
B. Faulty wiring	Check wiring from CABIN ALT WARN LT circuit breaker through flow sensor

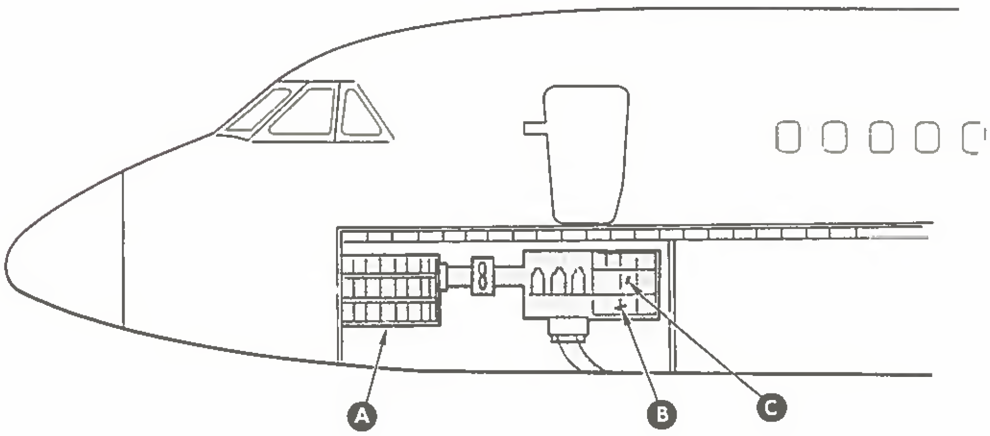
When the LOW AIR FLOW warning light illuminates during flight, the electronic equipment cooling fan must be manually turned on and the electronic equipment cooling valve must be closed. Cooling of the components is then accomplished in the same manner as during ground cooling operations.

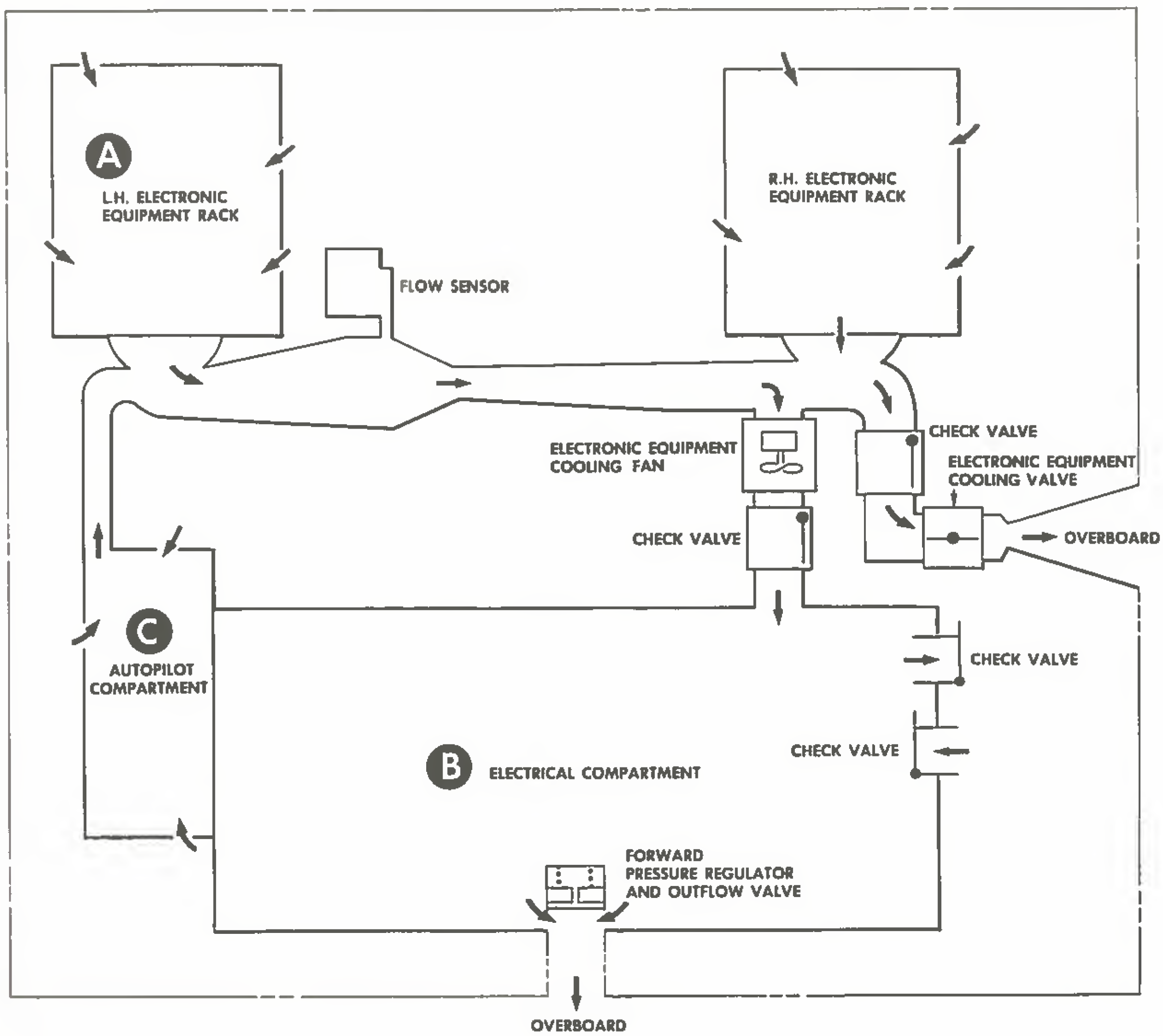
The autopilot equipment and the electrical equipment do not employ forced ventilation through the components. They are cooled by the general circulation of air around the equipment.

The electrical equipment compartment contains two check valves which control the airflow through the compartment. One valve permits cooling air to flow into the compartment for normal operations. The other valve opens at approximately 2 inches of water pressure to allow the cooling air to flow out of the electrical compartment should the forward outflow valve fail in the closed position.



Electronic Equipment Cooling
Control Schematic
Figure 2





Electronic Equipment Cooling
Air Flow Schematic
Figure 1

ELECTRONIC EQUIPMENT COOLING SUBSYSTEM
DESCRIPTION AND OPERATION

1. General

The compact design of modern electronic equipment and the increased use of transistors have established the need for a positive flow of cooling air through the equipment. Cooling is necessary to maintain the electronic components and their circuit characteristics at their designed values. There are two methods of supplying the cooling air. In flight, when the airplane is pressurized, the flow of cooling air is provided by routing conditioned, pressurized air from the passenger compartment to the electronic and electrical compartments. After flowing through or around the components, the cooling air is then dumped overboard through the electronic equipment cooling valve or through the forward pressure regulating outflow valve. When the airplane is on the ground, or when not pressurized in flight, an electric fan provides the flow of cooling air.

Switches for control of the electronic equipment cooling fan and the electronic equipment cooling valve are located on the flight engineer's panel. A LOW AIR FLOW warning light adjacent to the switches indicates inadequate cooling. See Figures 1 and 2 for schematic illustrations of electronic equipment compartment cooling.

2. Operation

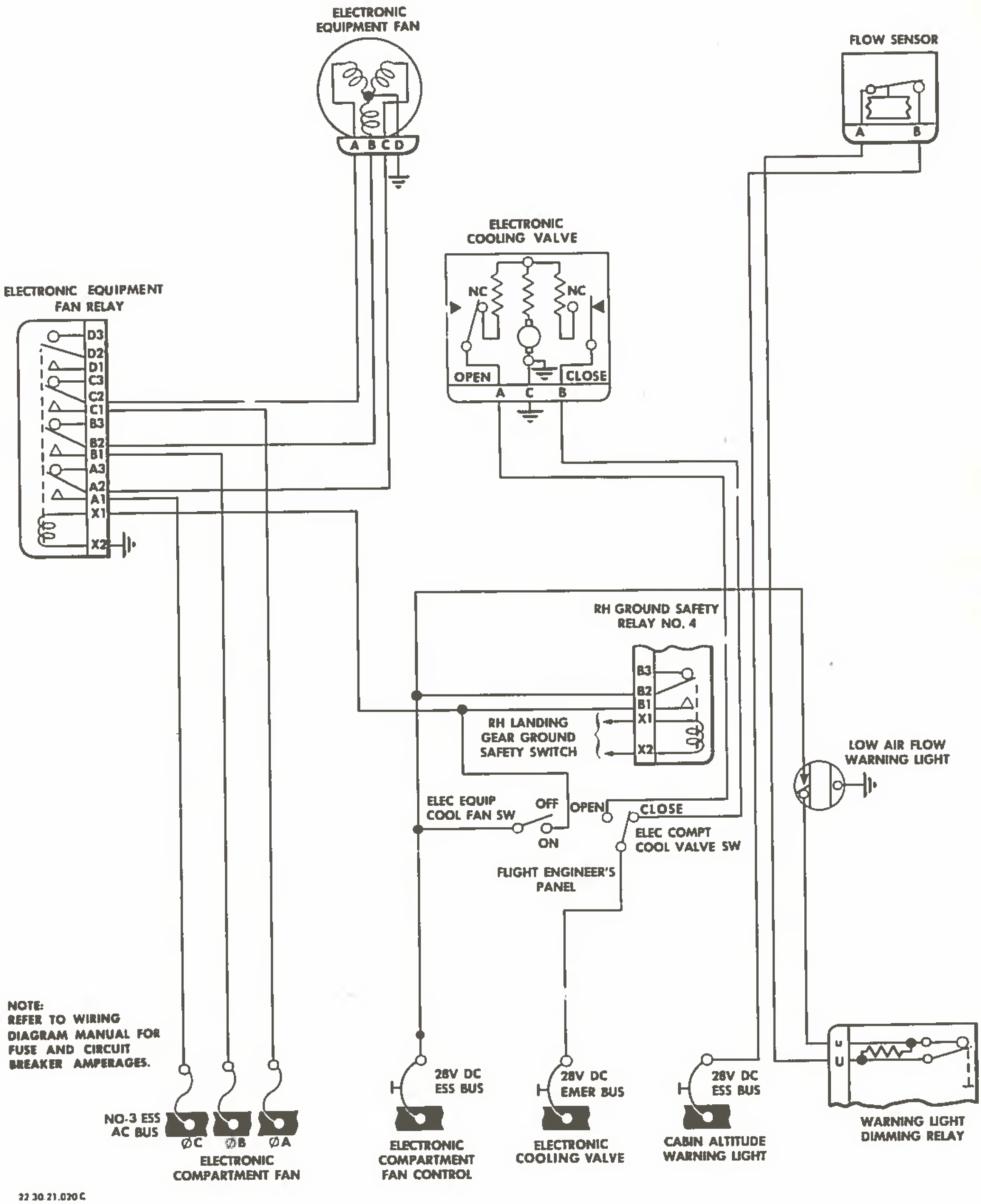
In order to meet the different cooling requirements of various components in the electronic and electrical equipment compartments, the compartments are divided into four distinct areas. They are the left electronic equipment racks, the right electronic equipment racks, the autopilot racks, and the electrical compartment. Cooling air flow through the first three areas follows the same pattern under all conditions, but the flow through the electrical compartment varies slightly when the cooling fan is used. Forced ventilation through components mounted in the electronic equipment racks is provided by a series of ducts built into the racks. The duct arrangement provides an opening under each component requiring forced ventilation. When the components are locked in position on the mounting rack, the bottom of the component case is sealed against the duct opening. Cooling air enters each component through louvers on the top and sides, and flows downward into the mounting rack duct system. The air collected by the mounting rack duct is then routed overboard through the electronic equipment cooling valve, or through the forward pressure regulating outflow valve. Airflow through the cooling valve is limited by a venturi downstream of the valve. Airflow is limited to maintain the proper outflow of air during pressurized flight periods. The cooling valve, controlled by the ELECT EQUIP COOLING VALVE switch, is used to prevent the flow of air (cabin pressurization) from being dumped overboard in the event one turbocompressor should fail.

During ground cooling operations, when the cooling fan is actuated (fan actuated automatically through operation of landing gear ground safety relay) both pressure regulating and outflow valves are actuated to the full open position. Cooling air from the fan is then exhausted overboard through the forward outflow valve.

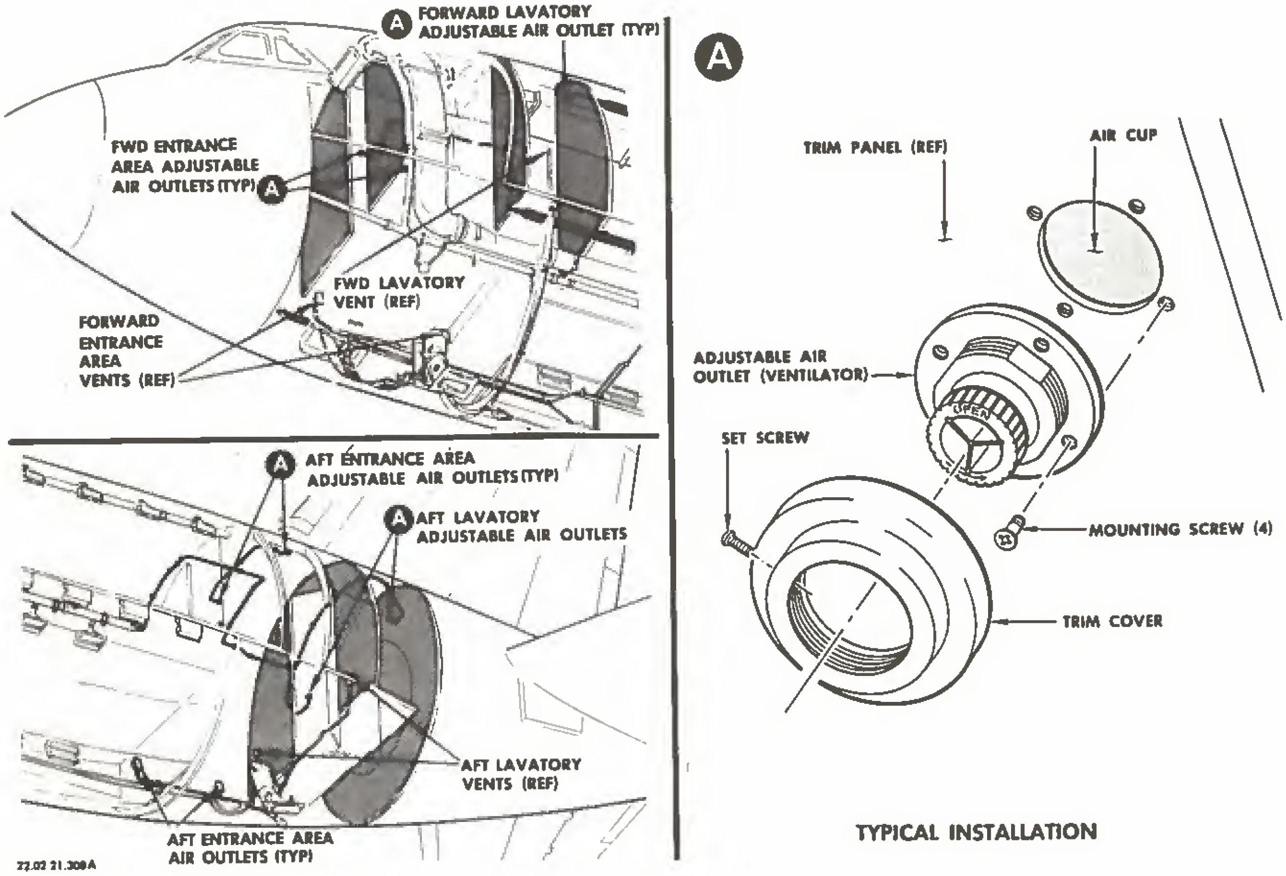
When the LOW AIR FLOW warning light illuminates during flight, the electronic equipment cooling fan must be manually turned on and the electronic equipment cooling valve must be closed. Cooling of the components is then accomplished in the same manner as during ground cooling operations.

The autopilot equipment and the electrical equipment do not employ forced ventilation through the components. They are cooled by the general circulation of air around the equipment.

The electrical equipment compartment contains two check valves which control the airflow through the compartment. One valve permits cooling air to flow into the compartment for normal operations. The other valve opens at approximately 2 inches of water pressure to allow the cooling air to flow out of the electrical compartment should the forward outflow valve fail in the closed position.



Electronic Equipment Cooling Control Schematic
Figure 2



Lavatory and Entrance Area Adjustable
Air Inlets (Ventilators) Installation
Figure 201

LAVATORY AND ENTRANCE AREA AIR DISTRIBUTION DUCTS - MAINTENANCE PRACTICES

1. Removal/Installation Lavatory and Entrance Area Adjustable Air Inlets (Ventilators) (see Figure 201)

   A. Equipment Required - None.

   B. Remove Lavatory and Entrance Area Ventilator.

      (1) Loosen small set screw securing ventilator trim cover to ventilator; unscrew trim cover from ventilator.

      (2) Remove screws securing ventilator mounting flange to air cup structure behind trim panel; remove ventilator.

   C. Install Lavatory and Entrance Area Ventilator.

      NOTE: Prior to installing ventilator ascertain that spiral groove inside valve body is free of chips or foreign matter which might cause the ventilator to bind and/or not seal properly in the closed position.

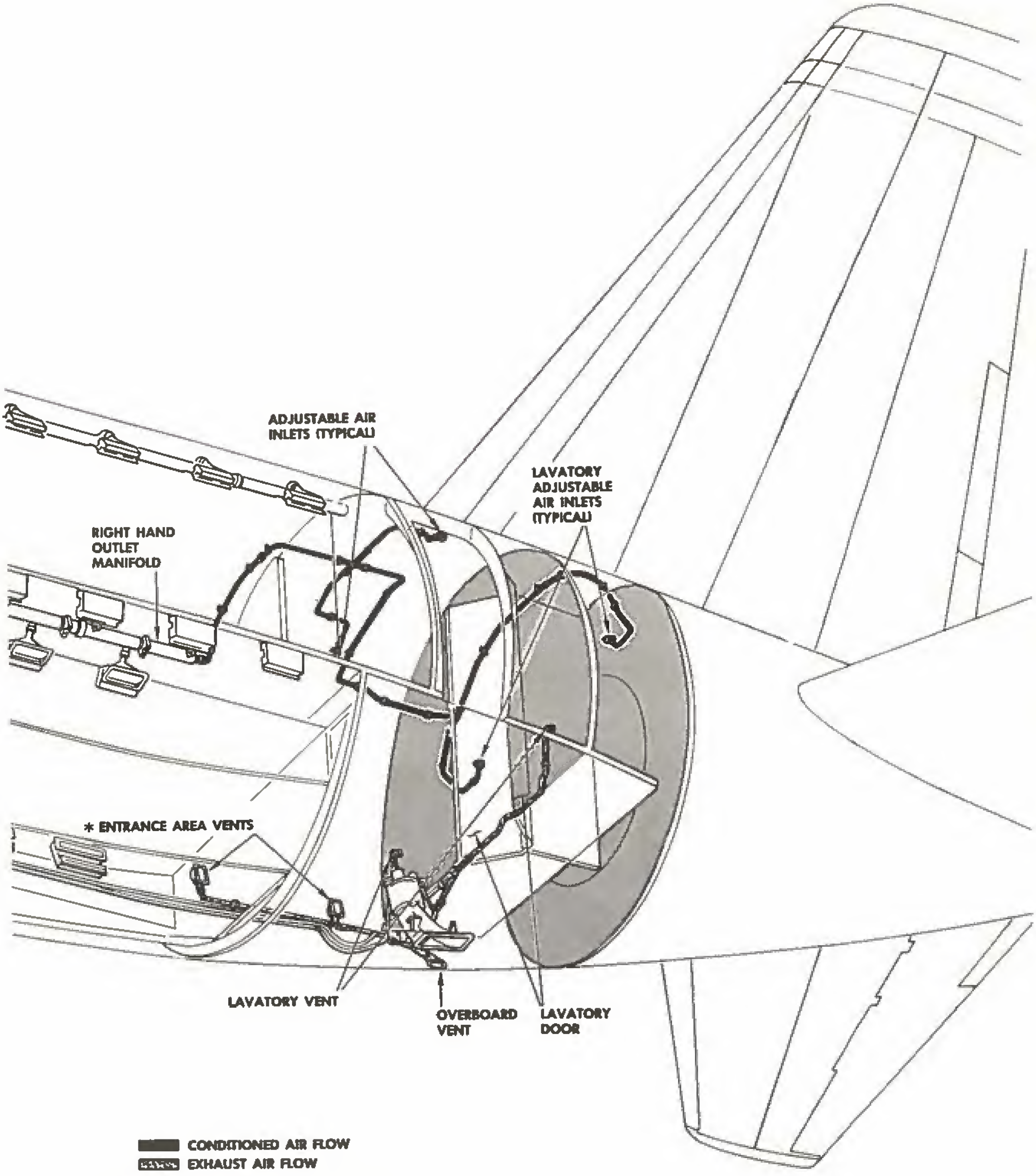
      (1) Place air inlet end of ventilator in air cup behind trim panel. Align holes in ventilator mounting flange with nutplates in air cup structure and secure ventilator with screws.

      (2) Screw threaded trim cover onto face of ventilator and secure cover with small set screw.

      (3) Perform Adjustment/Test of lavatory and entrance area ventilators.

2. Adjustment/Test Lavatory and Entrance Area Adjustable Air Inlets (Ventilators)

   For Adjustment/Test of the lavatory and entrance area ventilators, refer to 21-8-2, Maintenance Practices.



EFFECTIVITY	
APPLICABLE TO AIRPLANES	
*	TYPICAL BUFFET VENTILATING SYSTEM CONNECTION POINTS FOR AIRPLANES WITH BUFFETS

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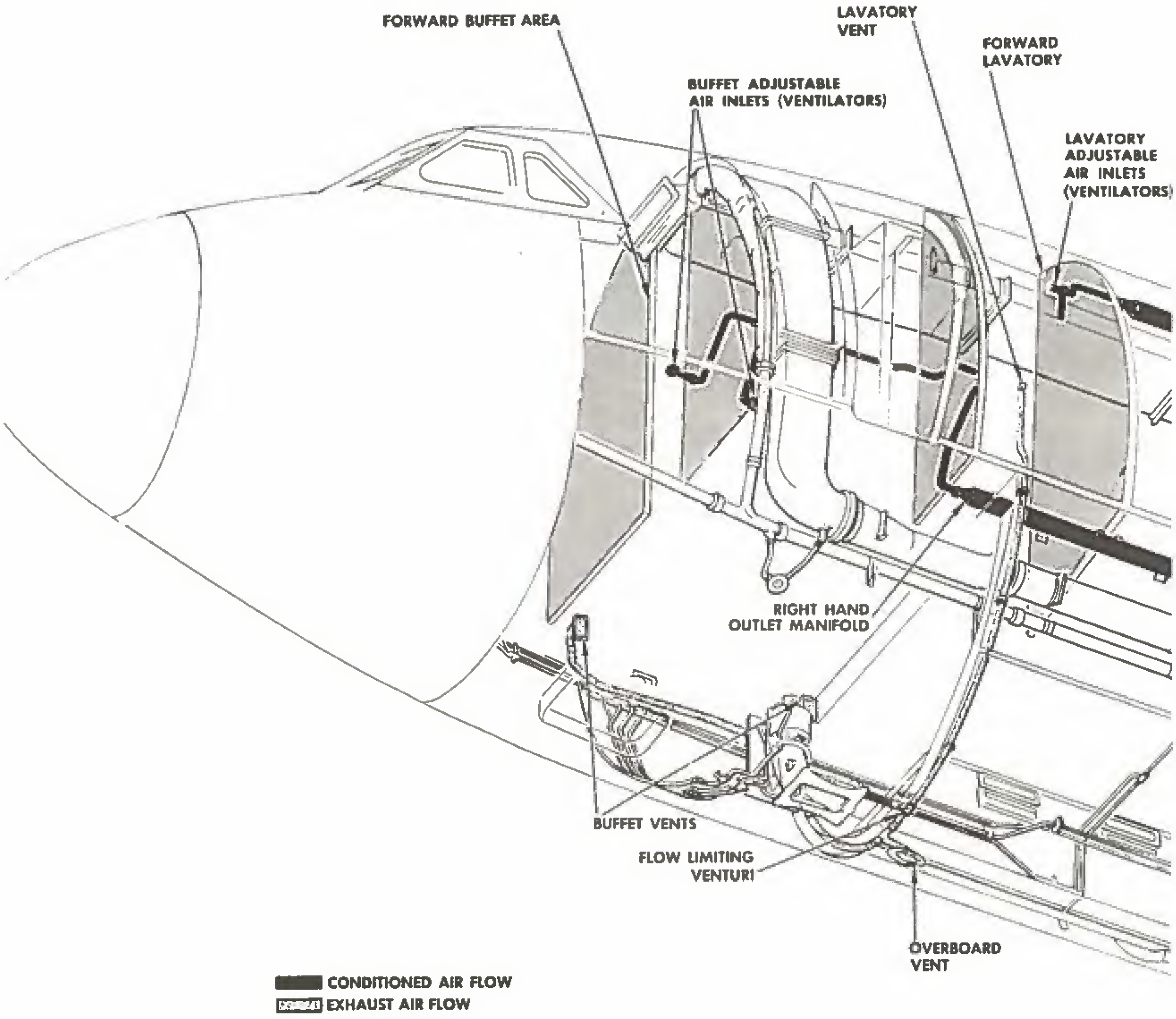
Lavatory and Entrance Area Air Distribution Ducts
Figure 1 (Sheet 2 of 2)



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Lavatory and Entrance Area Air
Distribution Ducts
Figure 1 (Sheet 1 of 2)

LAVATORY AND ENTRANCE AREA AIR DISTRIBUTION SYSTEM - DESCRIPTION AND OPERATION

1. Description

The lavatories and entrance areas are equipped with adjustable conditioned air inlets (ventilators) and overboard exhaust vents for ventilation. The ventilators receive air from the air supply manifold in the passenger cabin. The forward area ventilators are connected by tubing to the right and left side air manifolds at points slightly ahead of the first passenger window. The aft ventilators are similarly connected, but to the right aft side air manifold only, at a point just forward of the aft service door.

The lavatory and entrance area exhaust vents are connected to a system of tubing, venturis, and overboard discharge ports which are independent of the normal airplane ventilating system. This system of ventilation prevents lavatory odors from entering the passenger areas since all lavatory air is discharged directly overboard. Lavatory exhaust air, as it flows through the venturis, provides another function by producing a vacuum source for the pressurization control system.

PASSENGER COMPARTMENT AIR DISTRIBUTION DUCTS - MAINTENANCE PRACTICES

1. Removal/Installation Passenger Convenience Pod Adjustable Air Inlet (Ventilators)

   A. Equipment Required - None.

   B. Remove Passenger Convenience Pod Ventilator.

      (1) Remove escutcheon trim from passenger convenience pod (refer to Chapter 25, FURNISHINGS).

      (2) Remove screws securing ventilator mounting flange to convenience pod; remove ventilator.

   C. Install Passenger Convenience Pod Ventilator.

      NOTE: Prior to installing ventilator ascertain that spiral groove inside valve body is free of chips or foreign matter which might cause the ventilator to bind and/or not seal properly in the closed position.

      (1) Place air inlet end of ventilator in passenger convenience pod air cup. Align holes in ventilator mounting flange with nutplates behind convenience pod structure and secure ventilator with screws.

      (2) Install convenience pod escutcheon trim (refer to Chapter 25, FURNISHINGS).

      (3) Perform Adjustment/Test of passenger convenience pod ventilator.

2. Adjustment/Test Passenger Convenience Pod Adjustable Air Inlet (Ventilator)

   A. Equipment Required - None.

   B. Perform Test of Ventilator.

      (1) Operate air conditioning system or connect external air conditioning unit to airplane ground air conditioning connection.

      (2) With air supplied to system, open and close ventilator several times checking for erratic operation and/or excessive leakage in the closed position.

         NOTE: The ventilator shall open and close easily and smoothly and shall not cause rotation of the ball in the ball socket.

      (3) If ventilator operates erratically or leaks excessively in the closed position, replace with a like serviceable unit. There is no cleaning, lubrication or adjustment required on these units when installed in the airplane.

compartment floor where it may go either forward or aft to the cabin pressure regulating outflow valves. The air routed forward is used to cool the electronic and electrical equipment compartments.

Cabin air from a single discharge vent is routed through a duct to the electronic equipment cooling manifold. This duct contains the cabin discharge thermal resistor (temperature pickup). Since cabin pressure or the electronic equipment cooling fan will provide a steady air flow past the thermal resistor, the temperature control always has an accurate indication of cabin temperature.

PASSENGER COMPARTMENT AIR DISTRIBUTION DUCTS - DESCRIPTION AND OPERATION

1. Description

The primary source of conditioned, pressurized air for the passenger compartment air distribution system is the cabin air conditioning package. See Figure 1. Under normal conditions, most of the output of the flight compartment air conditioning package is also delivered to the passenger compartment. If it should become necessary to shut down the cabin air conditioning system, the flight compartment system will supply an adequate flow for reasonable passenger comfort. From the forward bulkhead of the air conditioning compartment, the passenger compartment supply duct is routed to the lower left side of the airplane. It then runs forward along the left side, outboard of the forward cargo compartment, to a point slightly forward of forward entrance door. At this point, the round duct connects with a vertical rectangular duct that routes the air to the top centerline of the fuselage. The vertical section follows the skin contour, passing through the forward coat closet, to an overhead duct arrangement installed between the fuselage structure and the interior trim.

From the forward entrance area a single large rectangular duct runs aft along the overhead centerline. At a point in line with the seventh passenger window from the front, the single duct branches into a left and right overhead duct. Each of these ducts supplies its respective forward and aft outlet manifolds. The left and right overhead ducts run parallel to the centerline and are offset approximately two and one-half feet. At a point in line with the twelfth passenger window from the front, a branch connects with the forward outlet manifold. Running farther aft, the left and right overhead ducts end with a connection to the aft outlet manifolds. This junction is at a point in line with the thirteenth passenger window from the aft end.

Conditioned air enters each outlet manifold at the midpoint. It then travels forward and aft to supply the side air inlets, the adjustable air inlets (ventilators), and the buffet and lavatory areas. The side air inlets are distributed along the entire length of the passenger compartment, and an adjustable ventilator is placed above each passenger seat. By supplying the air through a large number of outlets, it is possible to circulate a relatively large volume of air without producing uncomfortable drafts at any location.

Cabin air is exhausted through discharge vents located near the floor along the entire length of the cabin. These vents route the air under the passenger compartment floor where it may go either forward or aft to the cabin pressure regulating outflow valves. The air routed forward is used to cool the electronic and electrical equipment compartments.

Cabin air from a single discharge vent is routed through a duct to the electronic equipment cooling manifold. This duct contains the cabin discharge thermal resistor (temperature pickup). Since cabin pressure or the electronic equipment cooling fan will provide a steady air flow past the thermal resistor, the temperature control always has an accurate indication of cabin temperature.

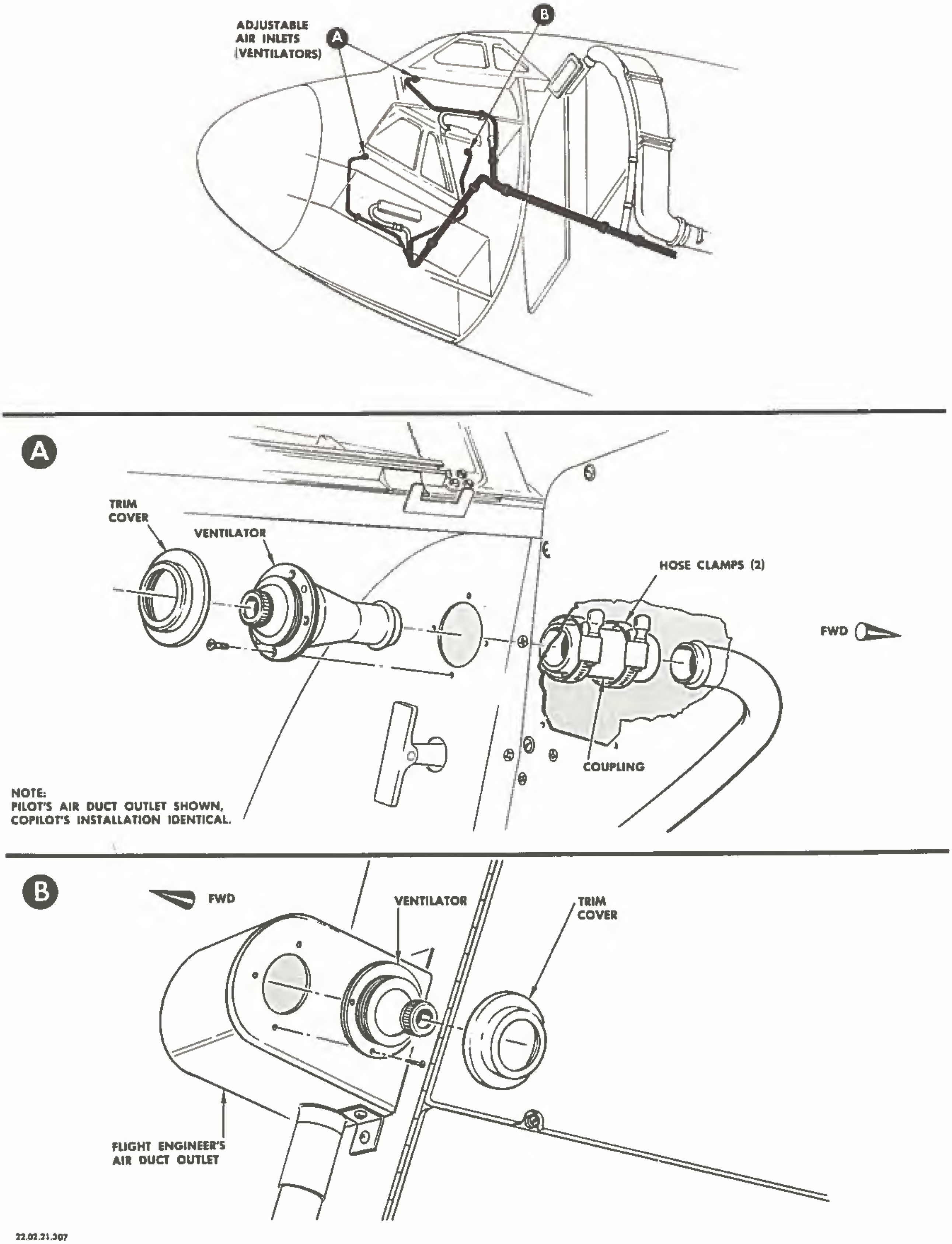
(1) Place inlet end of ventilator into air cup; align holes in ventilator mounting flange with nutplates in air cup structure. Secure ventilator with screws.

(2) Screw threaded trim cover onto face of ventilator; tighten trim cover.

(3) Perform Adjustment/Test of flight engineer's ventilator.

2. Adjustment/Test Flight Compartment Adjustable Air Inlets (Ventilators)

For Adjustment/Test of the flight compartment ventilators, refer to 21-8-2, Maintenance Practices.



Flight Compartment Ventilator Installation
Figure 201

FLIGHT COMPARTMENT AIR DISTRIBUTION DUCTS - MAINTENANCE PRACTICES

1. Removal/Installation Flight Compartment Adjustable Air Inlets (Ventilators) (see Figure 201)

   A. Equipment Required - None.

   B. Remove Pilots' Ventilators.

      (1) Unscrew threaded trim cover from face of ventilator.

      (2) Release clamps from coupling which connects ventilator to tubing on back side of instrument panel.

      (3) Remove screws securing ventilator to instrument panel and remove ventilator. (Cover open tubing to prevent entrance of foreign matter.)

   C. Install Pilots' Ventilators.

      NOTE: Prior to installing ventilators ascertain that spiral groove inside valve body is free of chips or foreign matter which may cause the ventilator to bind and/or not seal properly in the closed position.

      (1) Insert duct end of ventilator through instrument panel. Connect ventilator duct to tubing with coupling and secure with clamps.

      (2) Align holes in ventilator mounting flange with holes in instrument panel and secure ventilator with screws.

      (3) Screw threaded trim cover onto face of ventilator; tighten cover.

      (4) Perform Adjustment/Test of pilots' ventilators.

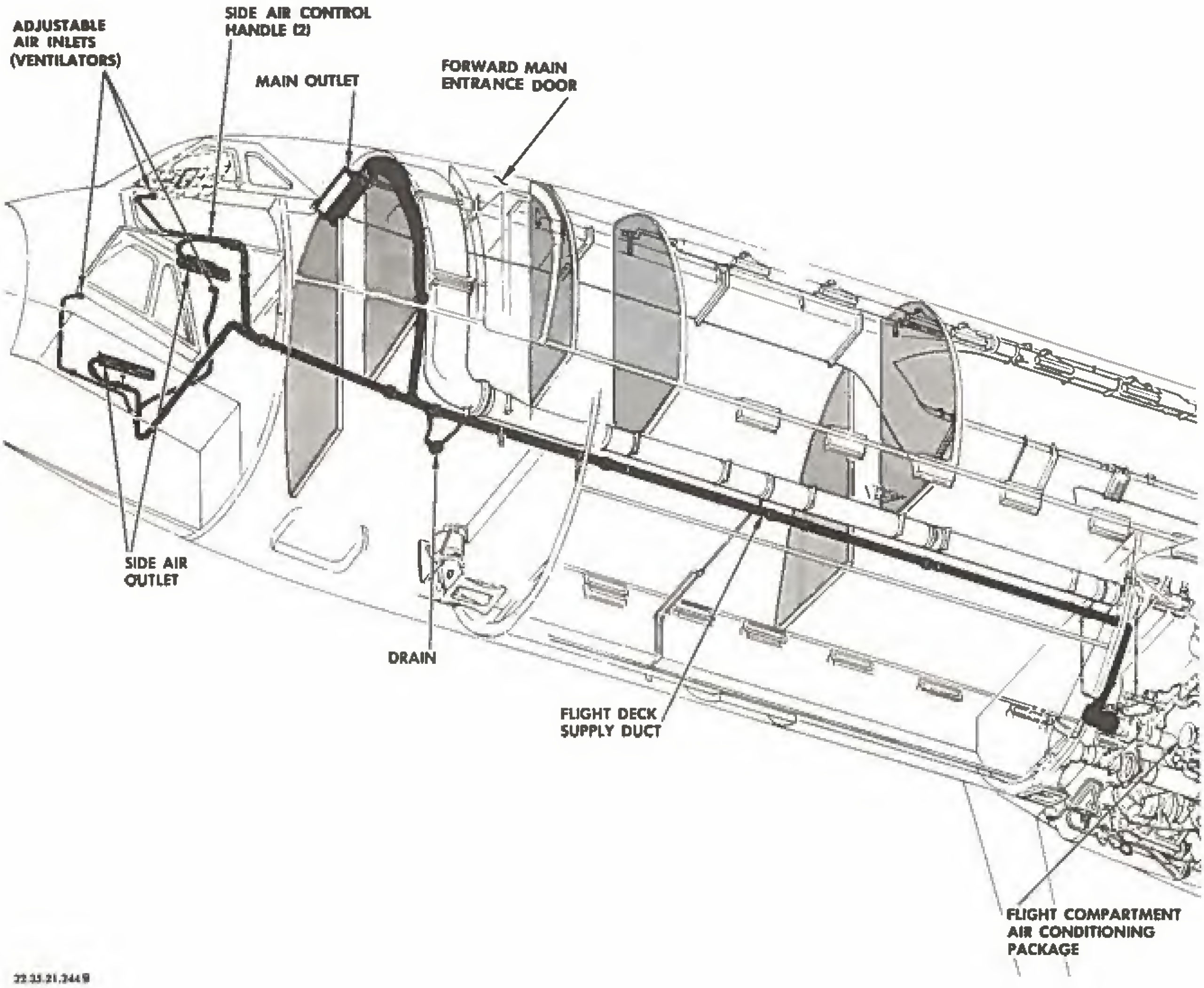
   D. Remove Flight Engineer's Ventilator.

      (1) Unscrew threaded trim cover from face of ventilator.

      (2) Remove screws securing ventilator to air cup structure and remove ventilator.

   E. Install Flight Engineer's Ventilator.

      NOTE: Prior to installing ventilator ascertain that spiral groove inside valve body is free of chips or foreign matter which may cause the ventilator to bind and/or not seal properly in the closed position.

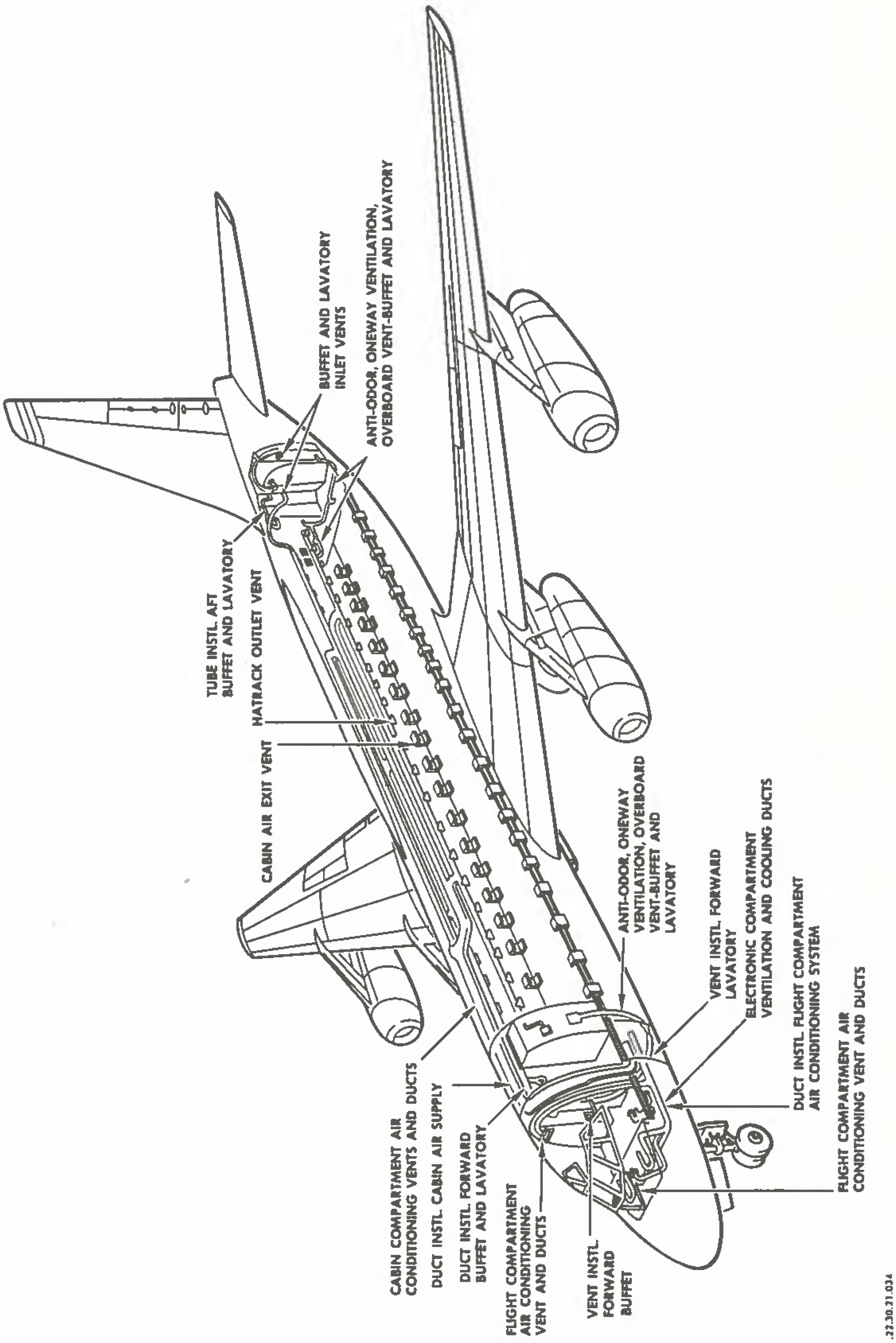


Flight Compartment Air Distribution Ducts
Figure 1

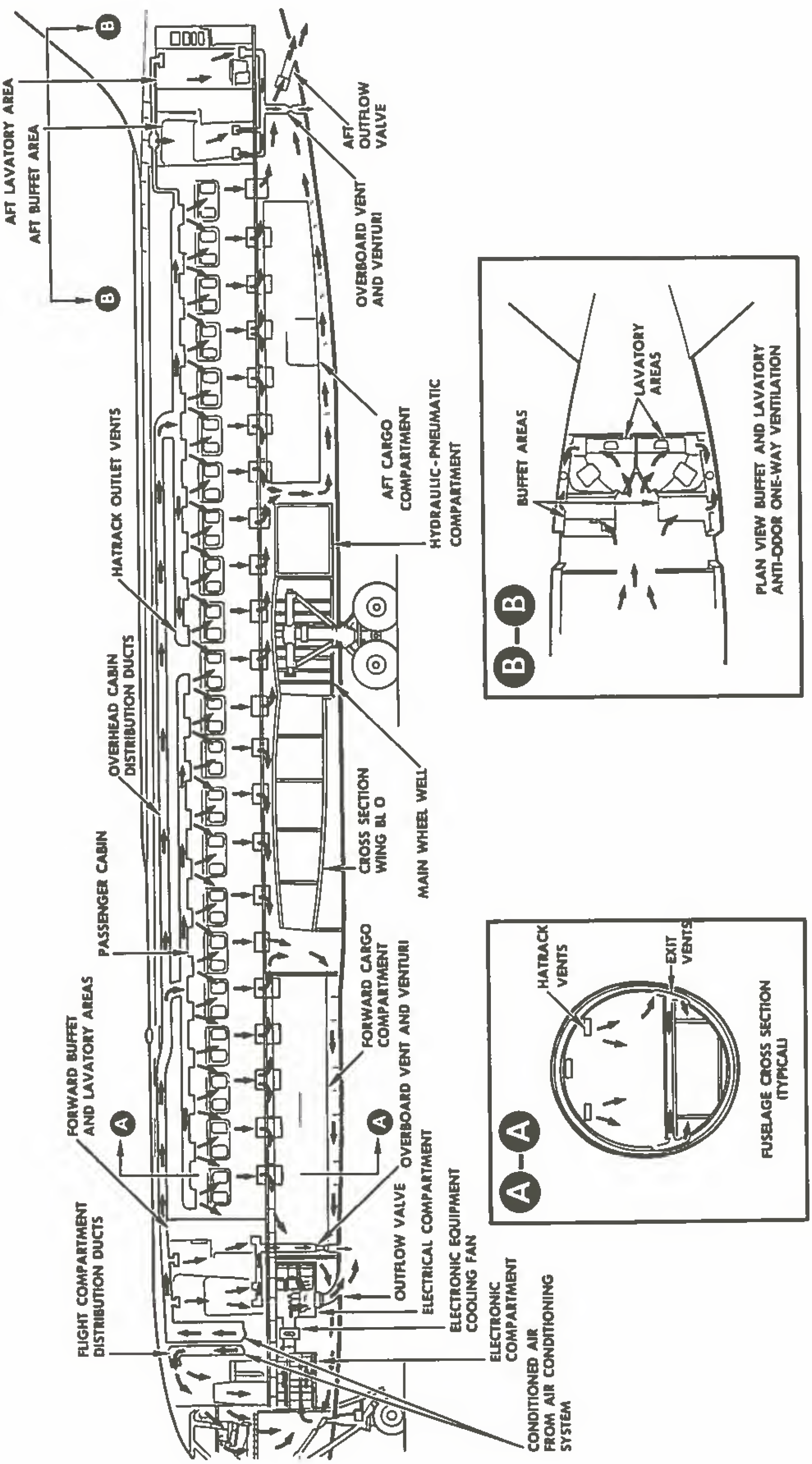
FLIGHT COMPARTMENT AIR DISTRIBUTION DUCTS - DESCRIPTION AND OPERATION

1. Description

The flight compartment air conditioning package normally delivers conditioned, pressurized air to the flight compartment air distribution system. If the flight compartment air conditioning system is shut down, an interconnection with the cabin air conditioning system will permit an adequate flow through the flight compartment ducts. From the forward bulkhead of the air conditioning compartment, the flight compartment air distribution duct is routed to the lower left side of the airplane. See Figure 1. It then runs forward along the left side, outboard of the forward cargo compartment, to the flight compartment. At a point just aft of the flight compartment, the distribution duct divides into two ducts. The larger of the two ducts curves upward, following the skin contour, to a point directly over the flight compartment door. It connects with a large discharge duct which extends through the bulkhead. The discharge duct directs the flow of air down and forward into the flight compartment. The smaller duct runs forward from the junction mentioned above to the area under the flight compartment floor. From this point it supplies the left and right side air inlets and the adjustable air inlets (ventilators) on the auxiliary instrument panels. Controls on the consoles regulate the flow through the side air inlets. An adjustable ventilator for the flight engineer's station is also supplied from this duct.



Air Distribution System
Figure 2



Air Flow and Pressurization Schematic
Figure 1

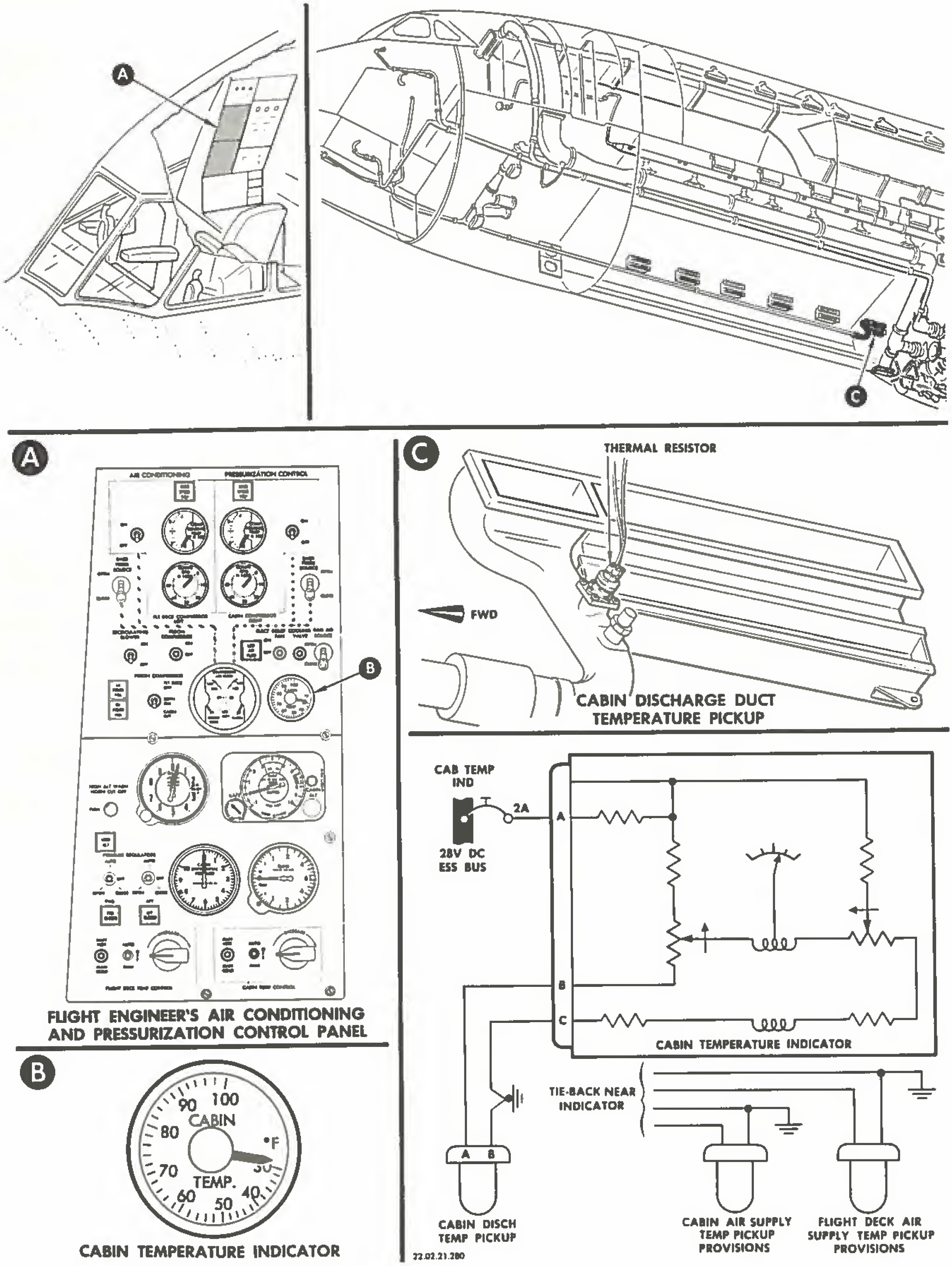
AIR DISTRIBUTION SYSTEM - DESCRIPTION AND OPERATION

1. General

The air distribution system delivers conditioned air from the air conditioning packages to the crew and passenger compartments. A schematic of the air flow is shown on Figure 1. The air distribution system is illustrated on Figure 2. Aluminum and fiberglass ducting is used to deliver the conditioned air to air inlets along the sides of the cabin just below the hat-racks. The location and design of the inlets permit an even distribution of conditioned air throughout the passenger compartment with no drafts at any passenger location. The ducts and inlet vents minimize sound generation by the conditioned air as it moves through the ducts and out of the vents. Additional adjustable air inlets (ventilators) are installed above each passengers seat next to the reading light on lower surface of the hat racks. Conditioned air for the flight compartment is delivered by aluminum and fiberglas ducting and discharged above the flight crew's heads and at their leg level. Adjustable ventilators are installed above and forward of each crew seat (except observer).

Conditioned air in the passenger cabin is exhausted from the cabin through exit vents installed outboard and below the seats. These vents direct the exhaust air into the area below the floor. The flight compartment air is also exhausted to the area below the floor. The air exhausted below the floor in the forward area of the cabin is directed through the electronics compartment for cooling and ventilation of the electronics equipment and then through the electrical compartment and overboard through the forward cabin pressure regulator and out-flow valve, or the electronic equipment cooling valve. The air exhausted below the floor in the aft area of the cabin is directed aft, around and below the baggage compartments to stabilize temperatures in the baggage compartments, and then further aft to the aft pressure regulator and outflow valve where the air is ported overboard.

To prevent odors from entering the passenger areas, all lavatories and buffets are ventilated by a one-way ventilation system. The conditioned air directed to these areas is vented directly overboard through tubing, a venturi to limit flow, and overboard vents.



Cabin Temperature Indicator
Figure 1

CABIN TEMPERATURE INDICATING SYSTEM - DESCRIPTION AND OPERATION

1. Description

The cabin temperature indicating system, shown on Figure 1, consists of a resistance-type temperature sensing probe in the cabin discharge air duct and an indicating gage on the flight engineer's control panel.

2. Operation

The temperature sensing probe in the cabin discharge air duct senses the temperature of the conditioned air as it leaves the cabin compartment. Temperature variations acting on the sensing probe varies the resistance of the probe; thus, an increase or decrease in temperature causes a corresponding increase or decrease in resistance. The resistance in the probe determines the current flow to the indicator which positions the pointer on the indicator dial.

Temperature sensing probes are installed in the conditioned air supply duct to determine air temperatures prior to entering the cabin and flight compartments. However, at present no connection is made to an indicating gage. The wires from the probes are tied back in the vicinity of the flight engineer's instrument panel.

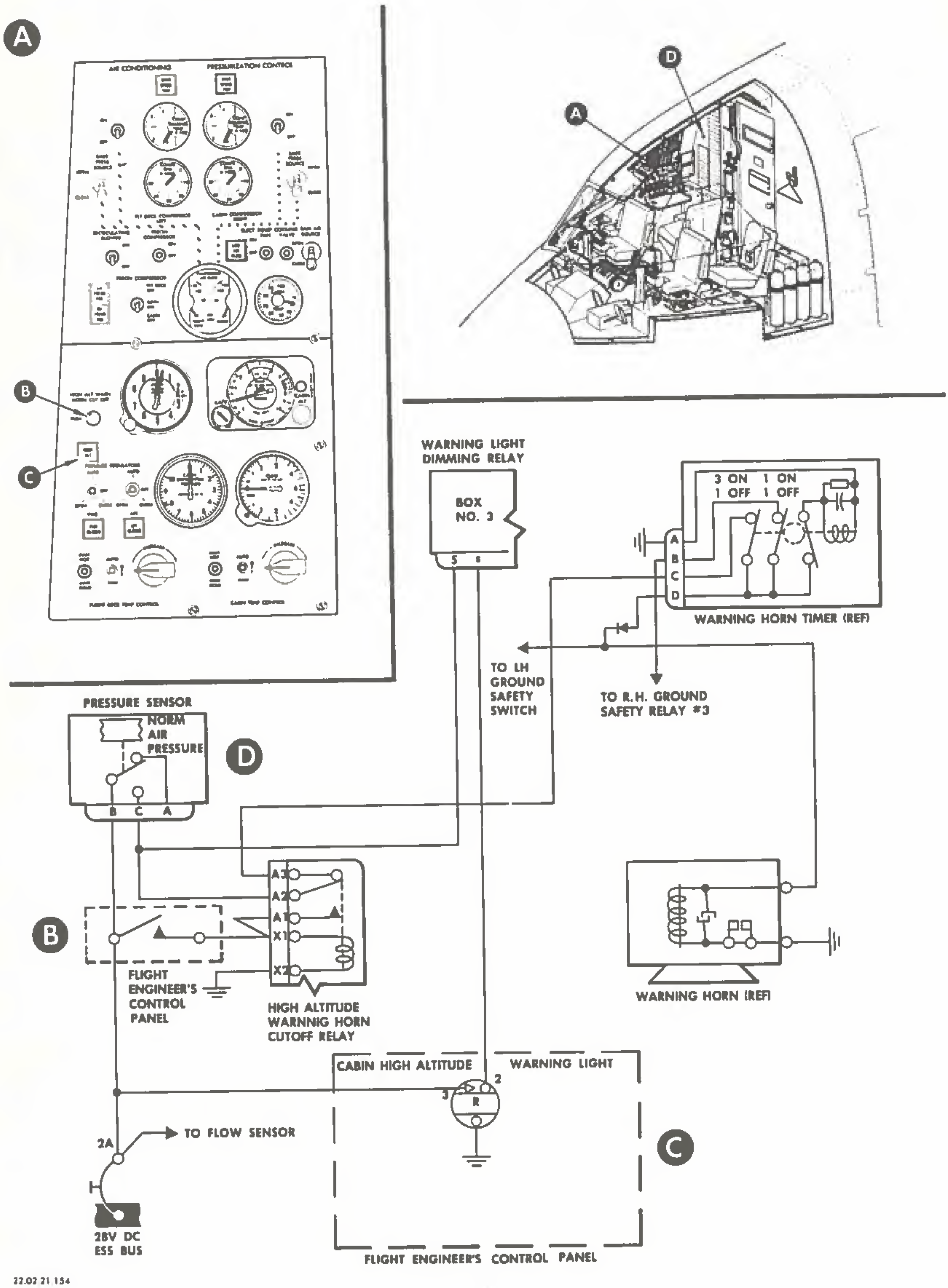
POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
	relay from socket. With cutout switch depressed, check for 28-volts dc at socket terminal X1. If 28-volts not present, check circuit from X1, through cutout switch to CABIN ALT WARN circuit breaker.
	If 28-volts dc is present at socket terminal X1, check for continuity between socket terminal X2 and ground. If no continuity, check wiring from socket terminal X2 to ground. If continuity is present, change relay.

5. WARNING HORN CUTS OUT ONLY WHILE CUTOUT SWITCH IS DEPRESSED

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
A. Faulty relay or wiring.	Remove high altitude warning horn relay from socket. Check for continuity between socket terminals A1 and X1. If no continuity, check wiring between A1 and X1. If continuity is present, change relay.

CABIN HIGH ALTITUDE WARNING SYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. NO WARNING LIGHT OR WARNING HORN WHEN CABIN ALTITUDE EXCEEDS 10,000 FEET	
A. Faulty pressure switch.	Remove connector from pressure switch located behind panel above the radio portion of main circuit breaker panel. Simulate high altitude by connecting terminals B and C of removed connector. If warning system operates, replace pressure switch.
B. Faulty wiring.	Remove pressure switch connector as outlined above. Check for 28-volts dc on terminal B or removed connector. If 28 volts present, check wiring to high altitude warning horn relay and to dimming relay. If 28 volts is not present, check wiring from terminal B to CABIN ALT WARN circuit breaker.
2. WARNING HORN SOUNDS BUT WARNING LIGHT INOPERATIVE	
A. Faulty light bulb.	Push PRESS-TO-TEST switch. If bulb does not illuminate, replace bulb. (See Chapter 31.)
B. Faulty wiring or dimming relay.	Check circuit from pressure switch through dimming relay to warning light.
3. WARNING LIGHT ILLUMINATES BUT WARNING HORN INOPERATIVE	
A. Faulty component in warning horn circuit.	Check operation of warning horn and warning horn timer. (See Chapter 31 INSTRUMENTS.)
B. Faulty wiring or high altitude warning horn relay.	Check circuit from pressure switch through high altitude warning horn relay to warning horn timer.
4. WARNING HORN WILL NOT CUT OUT WHEN CUTOUT SWITCH IS ACTUATED	
A. Faulty cutout switch.	Check operation of switch.
B. Faulty wiring or high altitude warning horn relay.	Remove high altitude warning horn



Cabin High Altitude Warning System
Figure 1

CABIN HIGH ALTITUDE WARNING SYSTEM - DESCRIPTION AND OPERATION

1. Description

The high altitude warning system, shown on Figure 1, provides a warning light and a warning horn when cabin altitude exceeds 10,000 feet. The red HIGH ALT warning light is located on the flight engineer's control panel. The light is illuminated when cabin altitude exceeds 10,000 feet. The warning horn sounds intermittently, 3 seconds on and 1 second off, to identify the high altitude condition. The horn can be stopped by momentarily pushing the HIGH ALT WARN HORN CUT-OFF button just above the HIGH ALT warning light. The warning horn cutout relay is automatically reset when cabin altitude goes below 10,000 feet.

2. Operation

The HIGH ALT warning light and warning horn are electrically actuated by a pressure sensing switch. The pressure switch is located behind the panel above the radio portion of the main circuit breaker panel.

B. Test Emergency Pressurization Shutoff Valve (cabin or flight compartment).

(1) With pneumatic and electrical power available, place the EMER PRESS SOURCE switch in the OPEN position for not more than 15 seconds. An airflow of approximately 40 pounds per minute should be indicated on the COMPRESSOR AIR FLOW indicator on the flight engineer's panel.

CAUTION: THE EMERGENCY-PRESSURIZATION SHUTOFF VALVE SHALL NOT BE OPENED FOR MORE THAN 15 SECONDS WHILE THE AIRPLANE IS ON THE GROUND. THE ABSENCE OF RAM AIR FOR COOLING THE HEAT EXCHANGER CAN LEAD TO EXCESSIVELY HIGH TEMPERATURES AT THE FREON EVAPORATOR

(2) After completion of test, shut down engine or disconnect ground carts as required.

(4) Connect electrical connector to valve receptacle.

(5) Close EMER PRESS circuit breaker.

(6) Perform Adjustment/Test of emergency pressurization shutoff valve.

(7) Close turbocompressor access door.

(8) Remove warning tag from cockpit.

E. Remove Flight Compartment Emergency Pressurization Shutoff Valve.

(1) Disconnect electrical connector from valve actuator. (Located above and forward of the turbocompressor.) (Cap connector and receptacle. Tag harness for installation.)

(2) Remove safety pins from duct clamps; remove nuts securing duct clamps and remove clamps.

(3) Remove gaskets between ducts and valve body.

(4) Remove emergency pressurization shutoff valve.

F. Install Flight Compartment Emergency Pressurization Shutoff Valve.

(1) Position emergency pressurization shutoff valve between duct ends with the direction of flow arrow pointing outboard. The electrical receptacle shall be above the actuator housing.

(2) Install gaskets between ducts and valve body.

(3) Install and secure duct clamp on each end of valve (refer to Chapter 36, PNEUMATIC).

(4) Connect electrical connector to valve receptacle.

(5) Close EMER PRESS circuit breaker.

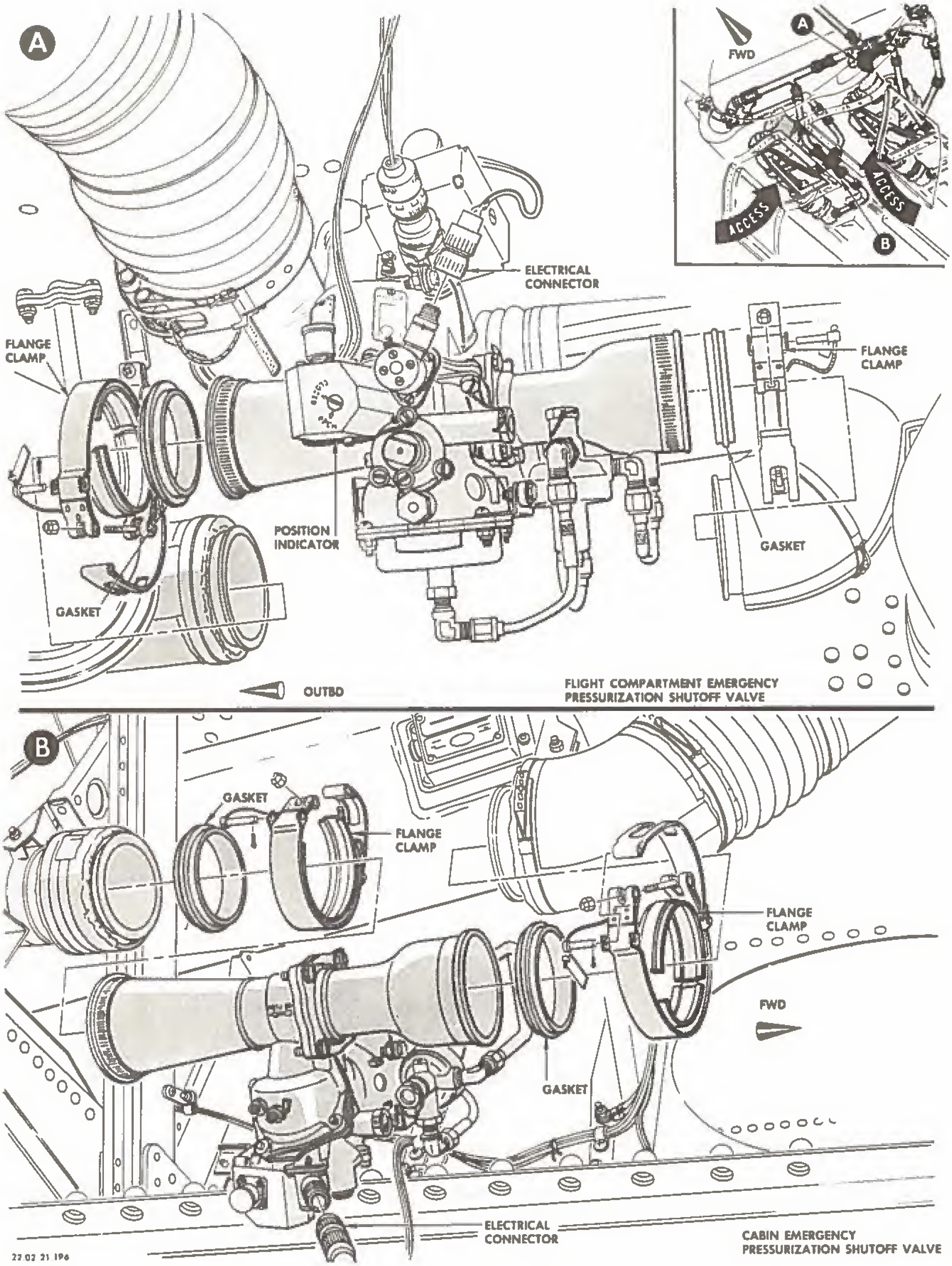
(6) Perform Adjustment/Test of emergency pressurization shutoff valve.

(7) Close turbocompressor access door.

(8) Remove warning tag from cockpit.

2. Adjustment/Test

A. Equipment Required and Preparation. A pneumatic and electrical power source. This can be obtained from ground carts or by operating one of the engines (refer to 21-0, Maintenance Practices).



Emergency Pressurization Shutoff
Valve Installation
Figure 201

EMERGENCY PRESSURIZATION SHUTOFF VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Emergency Pressurization Shutoff Valve (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open EMER PRESS circuit breaker (cabin or flight compartment as required).

      (2) Open turbocompressor access door (cabin or flight compartment as required).

      NOTE: The cabin emergency pressurization shutoff valve is accessible upon opening the access door. The flight compartment emergency pressurization shutoff valve is accessible only after removal of the turbocompressor package (refer to 21-1-0, Maintenance Practices).

      (3) Place warning tag in cockpit to prevent other personnel from starting the engines, or connecting a ground pneumatic supply.

      CAUTION: REMOVAL OF AN EMERGENCY PRESSURIZATION SHUTOFF VALVE WILL LEAVE AN OPENING IN THE MAIN BLEED AIR MANIFOLD. DO NOT OPERATE ENGINES OR PRESSURIZE THE MANIFOLD WITH A GROUND CART WHILE THE VALVE IS REMOVED.

   C. Remove Cabin Emergency Pressurization Shutoff Valve.

      (1) Disconnect electrical connector from valve actuator. (Cap connector and receptacle. Tag for installation.)

      (2) Remove safety pins from duct clamps; remove nuts securing duct clamps and remove clamps.

      (3) Remove gaskets between ducts and valve body.

      (4) Remove emergency pressurization shutoff valve.

   D. Install Cabin Emergency Pressurization Shutoff Valve.

      (1) Position valve between duct ends with the direction of flow arrow pointing aft. The actuator shall be on the inboard side with the electrical receptacle pointing down.

      (2) Insert gaskets between ducts and valve body.

      (3) Install and secure duct clamp on each end of valve (refer to Chapter 36, PNEUMATIC).

The flow-regulating spoon valve is mounted in bearings in the valve body and is mechanically linked to the pneumatic actuator. Setscrews in the valve body are adjusted to limit travel of the spoon valve.

The valve position indicator switch is installed under a cover on a switch support which is attached to the pneumatic actuator body. The switch is actuated by an indicator shaft which extends through the switch support and engages with the spoon valve shaft. The switch is open when the spoon valve is closed; the switch is closed to complete an indicator circuit when the spoon valve is five degrees or more open from the full-closed position. The indicator shaft protrudes through the switch cover and a notch on the end of the shaft points to the words OPEN and CLOSED, stamped on the switch cover, to visually indicate the position of the spoon valve.

2. Operation

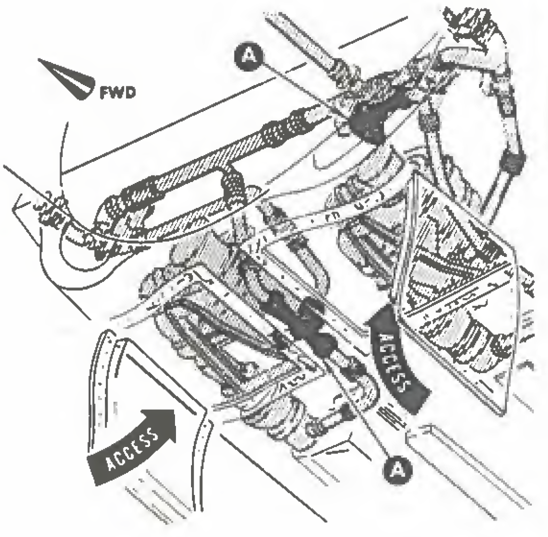
When the control solenoid is not energized, the pneumatic control system is inoperative, the spoon valve in the valve body is held closed by the actuator diaphragm backing spring.

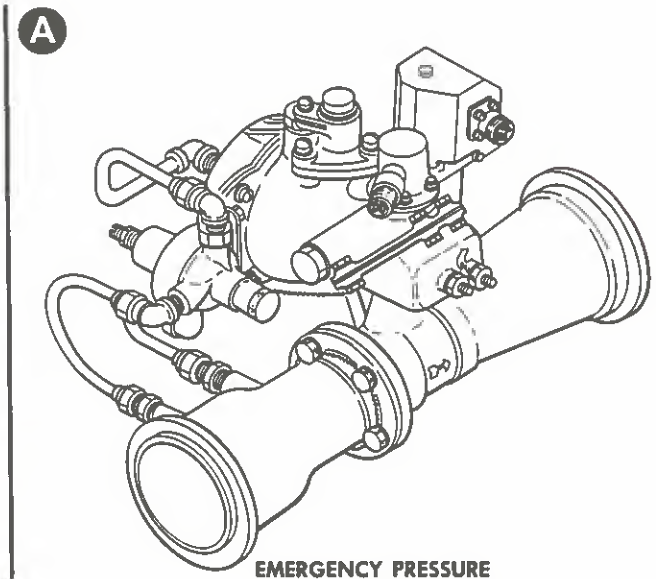
When the control solenoid is energized, the solenoid valve is positioned to open a passage from port A on the upstream side of the valve body to the pressure regulator and the pneumatic actuator. The minimum valve opening pressure is 9 psig.

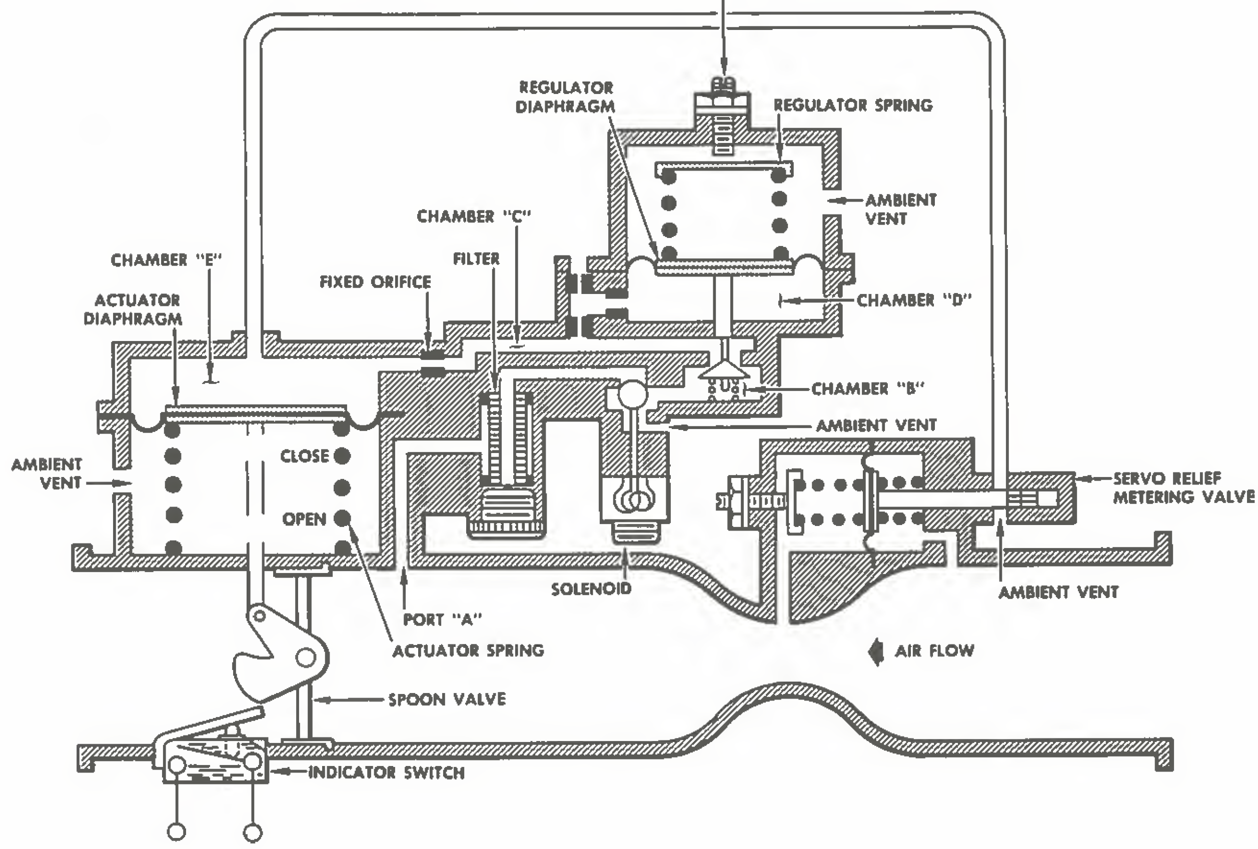
The pressure regulator maintains a constant differential pressure between chambers C and D and ambient. The consequent movement of the regulator diaphragm and regulator valve modulates the inlet pressure entering the regulator. The pressure from chamber C is supplied through an orifice to the actuator diaphragm chamber F to oppose the valve-closing force of the diaphragm backing spring.

When the venturi inlet-to-throat differential pressure becomes greater than the calibrated value, the servo diaphragm positions the servo relief metering valve to bleed pressure from chamber E of the pneumatic actuator, moving the spoon valve toward closed position. The servo relief metering valve regulates actuator pressure in chamber E to rise and fall with varying air flow through the venturi tube. Resulting movements of the actuator diaphragm and spoon valve control airflow through the valve body to the scheduled value.

When the control solenoid is de-energized, the solenoid valve closes the passage from port A to the pressure regulator and the pneumatic actuator, and vents residual pressure from the regulator and actuator to ambient. The actuator diaphragm is moved toward closed position by the backing spring, and the spoon valve is closed. The indicator switch and circuit open when the spoon valve is less than five degrees open.







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Emergency Pressurization Shutoff Valve
Figure 1

EMERGENCY PRESSURIZATION SHUTOFF VALVE - DESCRIPTION AND OPERATION

1. Description

The emergency pressurization shutoff valve, illustrated on Figure 1, consists of a flow-measuring venturi tube in series with, and upstream of, a flow-regulating spoon valve, a pneumatic actuator (mechanically linked to the spoon valve), a pressure regulator assembly, a servo relief metering valve, an air filter, a shutoff solenoid valve, and a valve position indicator electrical switch.

The venturi tube is connected to the air-flow duct of the valve body with four bolts. Pressure sensing ports, located at the inlet and throat of the venturi tube, are connected by tubing to the servo relief metering valve.

The servo relief metering valve is mounted on a bracket which is attached to the pneumatic actuator body. It comprises an inlet pressure chamber, connected by tubing to the venturi tube inlet port, and a throat pressure chamber, connected by tubing to the venturi tube throat port. The chambers are separated by a spring loaded diaphragm which presses against a spring-loaded pressure-relief metering valve. The metering valve is connected by tubing to the actuator pressure chamber of the pneumatic actuator.

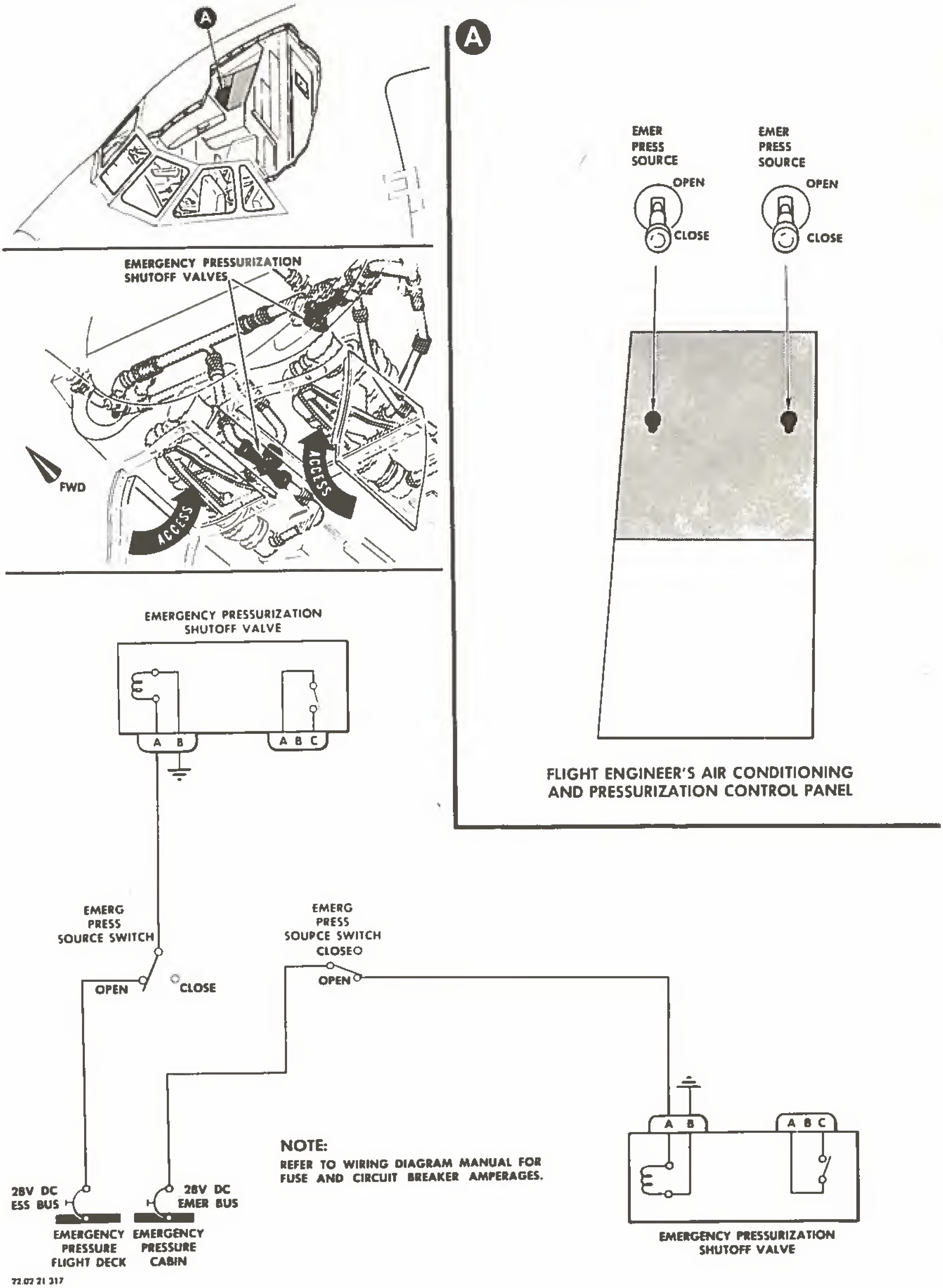
The pneumatic actuator consists of a body and cover, bolted to the valve body, containing a diaphragm separating an ambient chamber and an actuator pressure chamber. The ambient chamber side of the actuator diaphragm is mechanically linked to the valve spoon and is spring-loaded to move the valve spoon to closed position. The ambient chamber is vented to ambient control air pressure from the solenoid valve, through the pressure regulator valve, to the actuator pressure chamber of the pneumatic actuator. The actuator pressure chamber is also connected by tubing to the servo relief metering valve.

The solenoid valve is a single-port poppet-type valve actuated by a control solenoid. It is mounted in the pneumatic actuator body and is positioned to open and close drilled passages in the actuator body.

The pressure regulator assembly, mounted in the pneumatic actuator body, contains a valve which is operated by a diaphragm separating an ambient chamber from a differential pressure chamber. The valve is positioned to open or close a passage between the solenoid valve and the actuator pressure chamber of the pneumatic actuator.

EMERGENCY PRESSURIZATION - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
CAUTION: THE EMERGENCY PRESSURIZATION SYSTEM SHALL NOT BE OPERATED FOR MORE THAN 15 SECONDS WHILE THE AIRPLANE IS ON THE GROUND. THE ABSENCE OF RAM AIR FOR COOLING THE AIR-TO-AIR HEAT EXCHANGER CAN LEAD TO EXCESSIVELY HIGH TEMPERATURES AT THE FREON EVAPORATOR.	
1. NO AIR FLOW INDICATED (BLEED AIR PRESSURE OK)	
A. Faulty air flow indicating system.	Operating only the suspected emergency pressurization valve, feel for air flow at any cabin outlet. If air is flowing, check air flow indicator, or flow sensor and transmitter.
B. Electrical malfunction.	Disconnect electrical connector from emergency pressurization shutoff valve. Place emergency pressure source switch in OPEN position. Check for 28-volts dc between pins A and B of the removed connector. If 28-volts dc not present, check continuity through emergency pressure source switch to the emergency pressure circuit breaker. If 28-volts dc is present, see paragraph 2.
2. AIR FLOW TOO HIGH, TOO LOW, OR FLUCTUATING	
A. Filter element clogged.	Remove, clean, and reinstall filter on the emergency pressurization shutoff valve.
B. Tubing connections leaking.	Check and tighten tubing connections on the emergency pressurization shutoff valve. If the above procedures do not eliminate the trouble, replace the emergency pressurization shutoff valve.



Emergency Pressurization Control Schematic
Figure 2

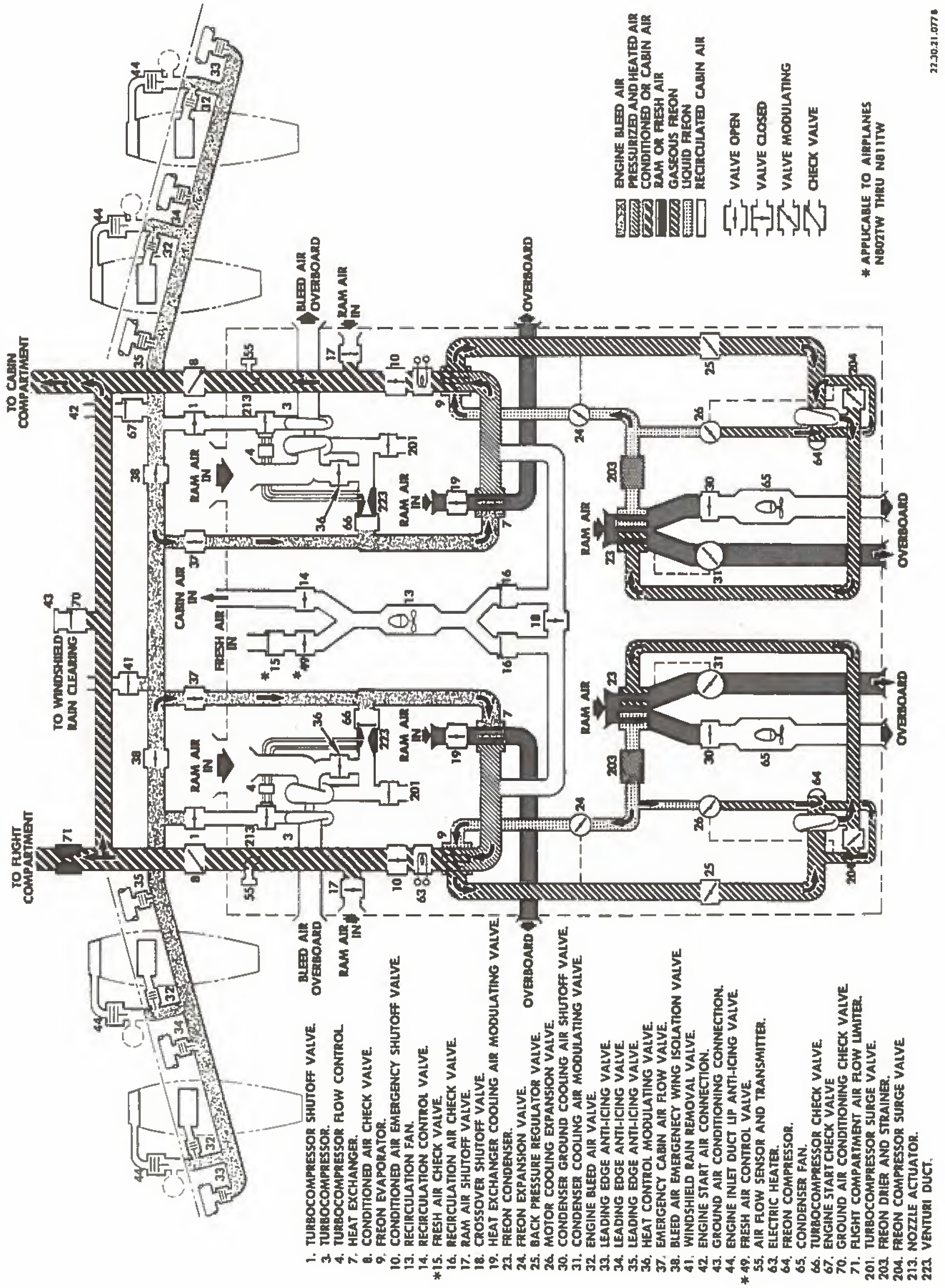
TEMPORARY REVISION NO. 21-40.

Insert facing 21-5-0, Page 3, dated July 25/62 (or subsequent).

The information in this temporary revision is applicable to airplanes not modified per Convair Service Bulletin 24-53. For airplanes that have been modified per Convair Service Bulletin 24-53, use the information on Page 3.

Retain this temporary revision in your manual until applicable airplanes have been modified per noted service bulletin.

Page 3, at lower left corner of art, both the CABIN and FLIGHT DECK EMERGENCY PRESSURE circuit breakers should be shown connected to the 28V DC ESS BUS.



Emergency Pressurization Flow Pattern
Figure 1

EMERGENCY PRESSURIZATION - DESCRIPTION AND OPERATION

1. General

Should both the flight deck and cabin turbocompressors malfunction at an altitude necessitating pressurization, engine bleed air can be utilized for emergency pressurization. The bleed air system will provide a total airflow of 80 pounds per minute, conditioned to a temperature comparable to the normal temperature of conditioned air.

When emergency pressurization is required, the turbocompressor shutoff valves for both the cabin and flight compartment pressurization systems are closed and both emergency pressurization shutoff valves are opened (see Figure 1). Bleed air enters the air conditioning system through the emergency pressurization shutoff valves and is ducted directly to the air-to-air heat exchanger and Freon evaporator for primary and secondary cooling as required by the temperature control system. A check valve prevents any bleed air from entering the compressor section of the turbocompressor. The emergency pressurization system should not be operated continuously for more than 15 seconds while the airplane is on the ground. This restriction is required because there is no ram air to cool the air-to-air heat exchanger, and the hot bleed air will soon cause overheating of the Freon evaporator.

The emergency pressurization shutoff valves are normally closed. They are opened by placing the EMER PRESS SOURCE switches in the OPEN position. When placed in the OPEN position, the switches route 28-volt dc power (see Figure 2) from their respective power busses to the emergency pressurization shutoff valves, thus, opening the valves and allowing bleed air to flow into the air conditioning system. The cabin valve receives power from the 28-volt dc emergency bus, and the flight deck valve receives power from the 28-volt dc essential bus. This arrangement provides a safety factor in case either of the busses should fail. Should one bus fail, the other will provide power to operate its respective emergency pressurization shutoff valve.

TEMPORARY REVISION NO. 21-39.

Insert facing 21-5-0, Page 1, dated July 25/62 (or subsequent).

The information in this temporary revision is applicable to airplanes not modified per Convair Service Bulletin 24-53. For airplanes that have been modified per Convair Service Bulletin 24-53, use the information on Page 1.

Retain this temporary revision in your manual until applicable airplanes have been modified per noted service bulletin.

Page 1, delete third (last) paragraph and substitute the following:

The emergency pressurization shutoff valves are normally closed. They are opened by placing the EMER PRESS SOURCE switches in the OPEN position. When placed in the OPEN position, the switches route 28-volt dc power from the 28-volt dc essential bus to the emergency pressurization shutoff valves, thus opening the valves and allowing bleed air to flow into the air conditioning system.

CONDENSER COOLING AIR CUT-OFF PRESSURE SWITCH - DESCRIPTION AND OPERATION

1. Description

The condenser cooling air pressure switch is a single pole, double throw, pressure operated, snap-action type switch. The switch and pressure unit are contained within a cylindrical housing which is approximately three inches in diameter and one and one half inches long. The cylinder contains a series of ram air pressure breather holes and an electrical receptacle on one end, and an ambient air pressure sensing port on the opposite end. The pressure switch is located outboard of the flight deck Freon package and senses ram air pressure in the air conditioning compartment.

2. Operation

When the airplane is in cruising flight, and ram air maintains compartment pressure above 0.50 ($\pm$ 0.07) psig, there is sufficient condenser cooling from ram air flow. However, when ram air pressure drops below approximately 0.5 psig, such as during a landing approach with the landing gear down and locked, the condenser cooling air pressure switch actuates. When the switch actuates it routes 28-volt dc power from the left hand landing gear down and locked switch to energize the No. 1 and No. 2 landing gear down and locked relays. The No. 1 down and locked relay, when energized, routes 115-volt ac power to close the condenser cooling air modulating valve, open the condenser ground cooling shutoff valve and start the condenser fan for the flight compartment air conditioning system. The No. 2 down and locked relay performs the same function for the cabin air conditioning system. Thus, a constant source of cooling air, either from ram air flow or from fan induced airflow, is provided to cool the Freon condenser when cooling is scheduled for the air conditioning system.

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Chapter 23
COMMUNICATIONS

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AUTOPILOT DISENGAGE SWITCHES - MAINTENANCE PRACTICES

1. Removal/Installation Autopilot Disengage Switches

   A. Equipment Required - None.

   B. Remove Disengage Switch.

      (1) Open AUTOPILOT and YAW DAMPER circuit breakers. Hang a warning sign on opened circuit breakers.

      (2) Remove clip ring that locks pushbutton switch in aileron control wheel as follows:

         (a) Hold the blade of a small screwdriver against one end of the ring to keep the ring from sliding in the locking groove of the grip.

         (b) With a sharp point, force the other end of the ring toward the button.

         (c) When the end of the locking ring is forced far enough out of the locking groove, put the blade of the screwdriver behind the ring and force the ring out of the locking groove. Be careful that the ring does not snap out of the switch assembly and become lost.

      (3) Withdraw the pushbutton switch and disconnect the four electrical leads. Tag wires for installation.

   C. Install Disengage Switch.

      (1) Connect the four switch leads of the aileron control wheel to the switch terminals in accordance with identification tags. (Wires marked E-20 and F-20 connect through one set of contacts: and wires marked C-20 and D-20 connect through the second set of contacts.)

      (2) Position the switch in the control wheel and force the locking ring into the locking groove.

      (3) Close AUTOPILOT and YAW DAMPER circuit breakers and remove warning signs. Engage autopilot system in either AUTOPILOT or YAW DAMPER mode.

      (4) Press the disengage switch to test operation. Autopilot system should disengage when disengage switch is actuated. That is, autopilot control panel engage switch should return automatically to OFF position when the disengage switch is actuated.

AUTOPILOT DISENGAGE SWITCHES - DESCRIPTION AND OPERATION

1. Description

An autopilot thumb-operated pushbutton disengage switch is located on the inboard side of the outboard grip of the pilot's and copilot's control wheels. The disengage switches are double-pole normally closed types. Electrical power circuits to the autopilot engage interlock relay solenoid complete through one set of contacts of the disengage switches. The ground circuit of the mode switch holding solenoid of the flight navigation instrument system completes through the second set of disengage switch contacts. Pilot's and copilot's disengage switches are wired in series.

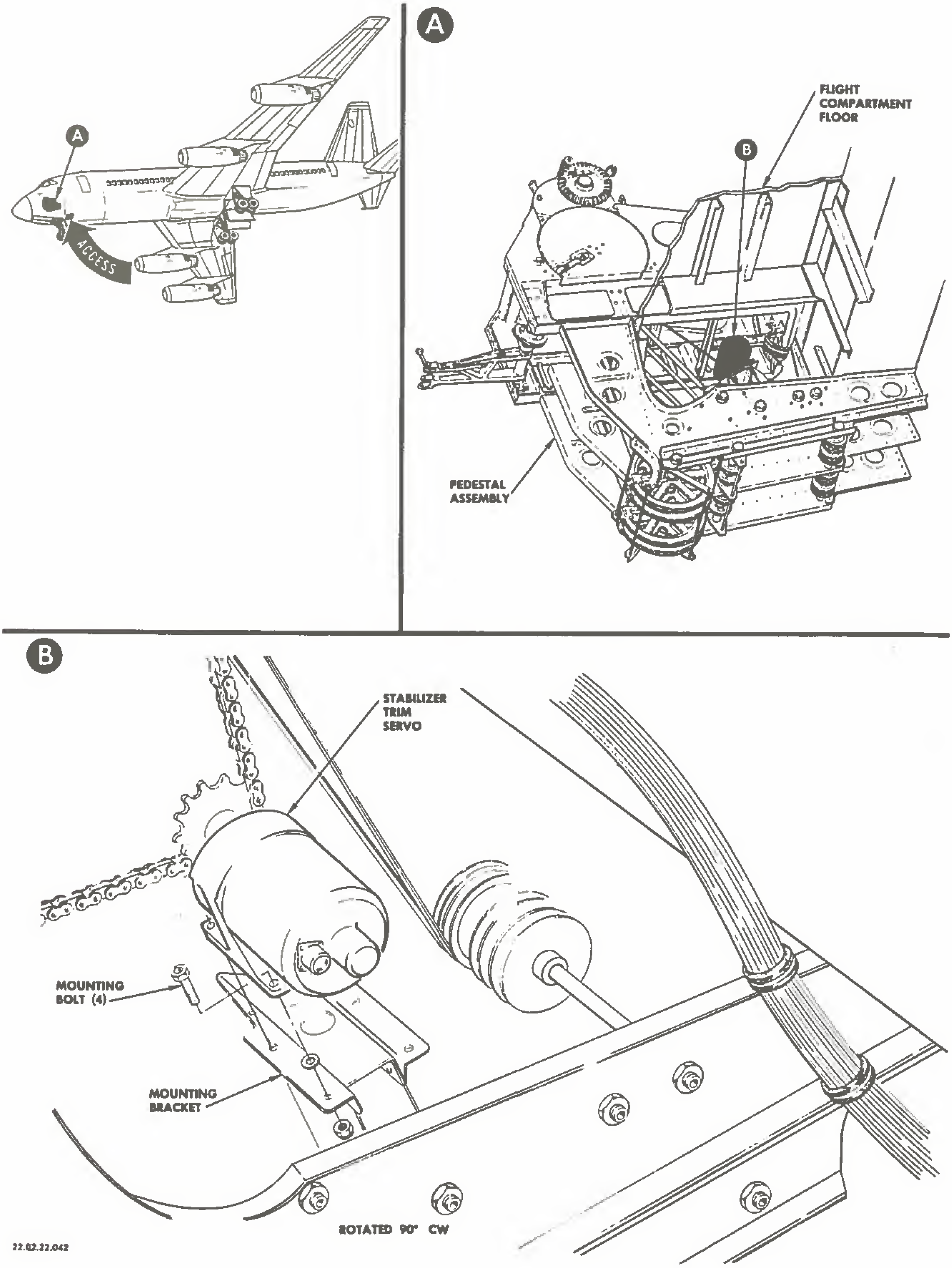
2. Operation

The schematic diagram of engage interlock relay K31, Figure 104, Sheet 1, shows the two functions of the control wheel disengage switches in the autopilot system.

A. If the autopilot system is engaged, actuating either of the disengage switches disengages the autopilot by interrupting electrical power to the engage interlock relay solenoid.

B. If the autopilot system has disengaged automatically or has been disengaged at the control panel and the autopilot off warning light is lighted, either control wheel disengage switch extinguishes the warning light.

The set of disengage switch contacts in the flight navigation system opens the ground circuit for the holding solenoid of the mode selector switch. When either autopilot disengage switch is actuated, the mode switch selection in the flight navigation system cancels and the mode selector switch returns automatically to off position. Refer to Chapter 34, NAVIGATION, for more details about the flight navigation system.



Stabilizer Trim Servo
Figure 201

STABILIZER TRIM SERVO - MAINTENANCE PRACTICES

1. Removal/Installation Trim Servo (see Figure 201)

   A. Equipment Required - None.

   B. Remove Trim Servo.

      (1) Open AUTOPILOT circuit breaker on the main circuit breaker panel in flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Open left tunnel access door.

      (3) Break safety wire, disconnect the electrical connector of the trim servo motor and cap the plug and receptacle.

      (4) Remove four bolts that secure the trim servo motor to structure. Retain bolts, nuts, and washers for reinstallation.

      (5) Lift the trim servo and disengage the sprocket from the drive chain.

   C. Install Trim Servo.

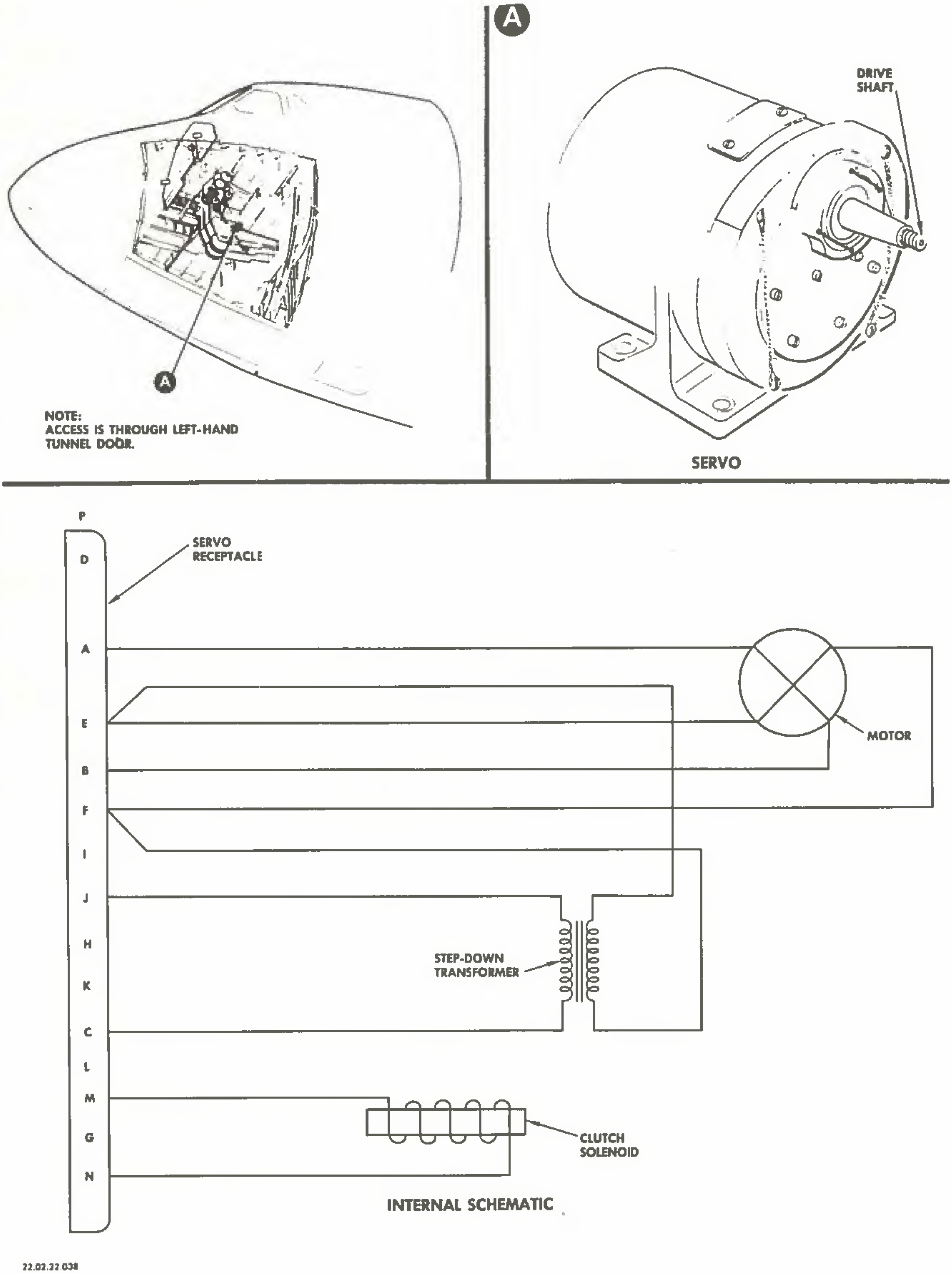
      (1) Set the trim servo on the mounting base with the sprocket engaged in the drive chain.

      (2) Install the four mounting bolts. Insert the same number of washers between the base of the trim servo and its mounting base as was originally installed. These washers determine the tension on the drive chain.

         NOTE: Make sure that the drive chain is correctly routed on the sprockets of the pedestal, the stabilizer trim wheel motor, and the idler.

      (3) Close AUTOPILOT circuit breaker and remove warning sign.

      (4) Test system operation, refer to 22-0, Adjustment/Test.



Stabilizer Trim Servo
Figure 1

STABILIZER TRIM SERVO - DESCRIPTION AND OPERATION

1. Description

A. Drive.

The stabilizer trim servo makes positioning adjustments to the stabilizer through a gear train, a solenoid-actuated clutch, and an output shaft. The servo is similar to the elevator servo and is controlled by the autopilot signals that control the elevator servo. The transformer in the trim servo steps down the voltage from the SA-40-C1 magnetic amplifier to a level compatible to the rate of the trim servo. Figure 1 shows an illustration of the stabilizer trim servo.

B. Electromagnetic Clutch.

The solenoid-actuated clutch that connects the gear train to the output shaft slips, when applied torque exceeds 36 inch-pounds.

C. Function.

The signal input to the stabilizer trim servo is parallel to the signal input to the elevator servo. When a load is held by the elevator control surfaces, the trim servo drives the stabilizer until the load is removed.

E. Install Rudder Servo Mount.

(1) Secure the servo mount to the mounting bracket with four screws.

(2) Re-rig the servo control cable on the servo and airplane cable pulleys. For rigging instructions refer to Chapter 27, FLIGHT CONTROLS.

(3) Close AUTOPILOT circuit breaker and remove warning sign.

(4) Test system operation, refer to 22-0, Adjustment/Test.

RUDDER SURFACE SERVO - MAINTENANCE PRACTICES

1. Removal/Installation Rudder Servo (see Figure 1)

A. Equipment Required - None.

B. Remove Rudder Servo.

(1) Open AUTOPILOT circuit breaker on the main circuit breaker panel in flight compartment. Hang a warning sign on opened circuit breaker.

(2) Post "DO NOT MOVE AIRPLANE SURFACE CONTROLS" signs on control wheels in flight compartment.

(3) Gain access to the rudder servo through the stabilizer screw jack access door.

(4) Break the safety wires on the electrical connector of the servo. Disconnect and cap the connector.

(5) Break the safety wires on the servo mounting screws and remove the screws. Support the servo while removing the screws.

(6) Disengage the servo from the servo mount.

C. Install Rudder Servo.

(1) Engage the splines of the servo output shaft and the servo mount pulley and install the mounting screws. Safety-wire the mounting screws.

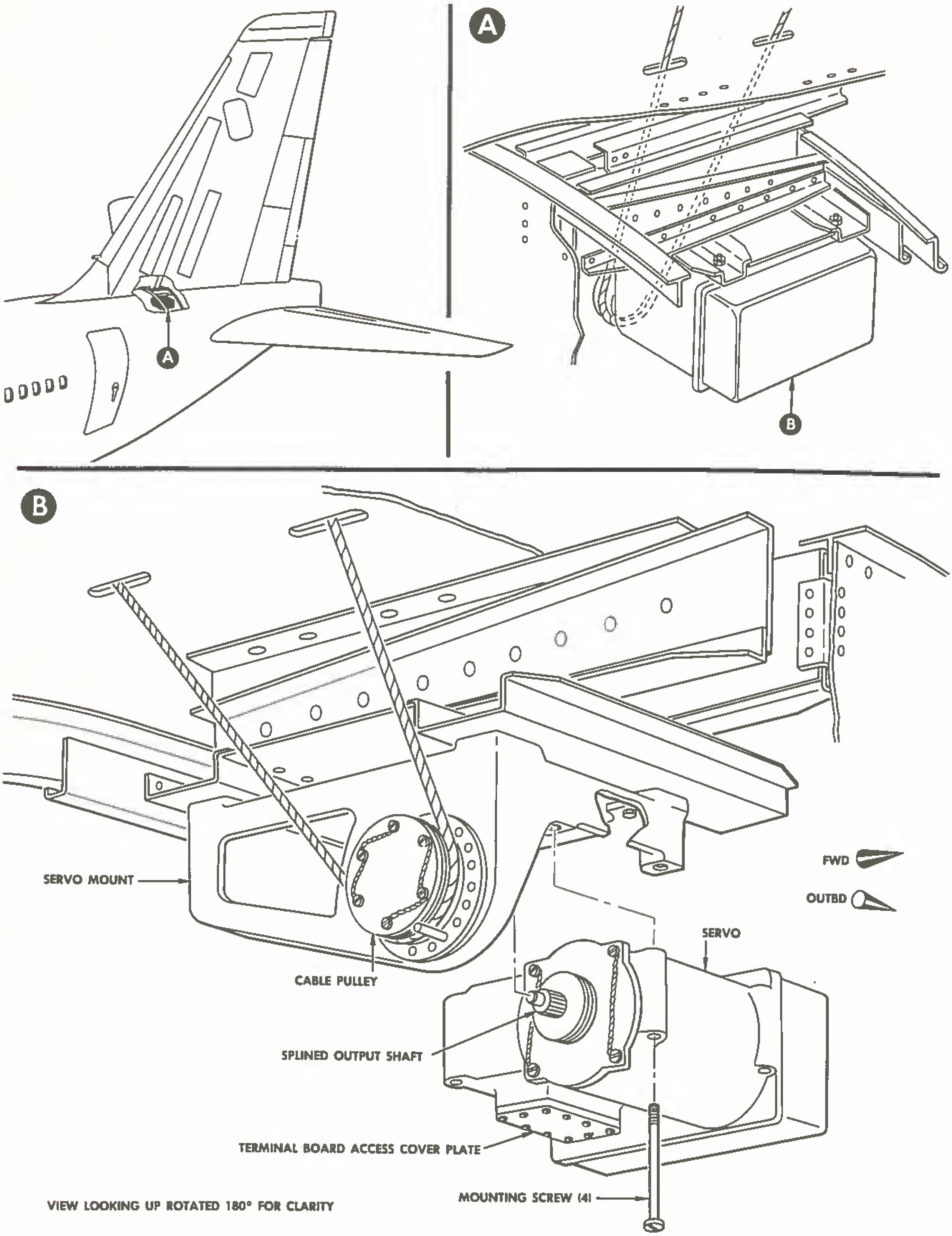
(2) Connect and safety-wire the electrical connector.

D. Remove Rudder Servo Mount.

(1) Remove rudder servo.

(2) Disconnect the rudder servo cable from the servo mount pulley.

(3) Remove four screws that secure the servo mount to its mounting bracket.



Rudder Servo
Figure 1

RUDDER SURFACE SERVO - DESCRIPTION AND OPERATION

1. Description

The rudder surface control servo is identical to the servo in the aileron control system; and the output shaft of the rudder servo connects by splines to the rudder control cable pulley in exactly the same manner that the aileron servo connects to the aileron control cable pulley. Figure 1 shows details of the rudder servo and cable installation and provides information about removal and installation procedures.

E. Install Elevator Servo Mount.

(1) Secure the servo mount to the mounting bracket with four screws.

(2) Re-rig the servo control cable on the servo and airplane cable pulleys. For rigging instructions refer to Chapter 27, FLIGHT CONTROLS.

(3) Remove warning signs from control wheels.

(4) Close AUTOPILOT circuit breaker and remove warning sign.

(5) Test system operation, refer to 22-0, Adjustment/Test.

ELEVATOR SURFACE SERVO - MAINTENANCE PRACTICES

1. Removal/Installation Elevator Servo (see Figure 1)

   A. Equipment Required - None.

   B. Remove Elevator Servo.

      (1) Open AUTOPILOT circuit breaker on the main circuit breaker panel in flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Post "DO NOT MOVE ELEVATOR" signs on control wheels in flight compartment.

      (3) Open the aft center fuselage access door for access to the elevator servo in the tail cone.

      (4) Break the safety wire on the electrical connector. Disconnect and cap the connector.

      (5) Break the safety wires on the mounting screws of the servo and remove the screws.

      (6) Lift the servo from the servo mount.

   C. Install Elevator Servo.

      (1) Position the elevator servo on the servo mount, engaging the splines of the servo output shaft with the splines of the cable pulley.

      (2) Install the mounting screws and safety-wire.

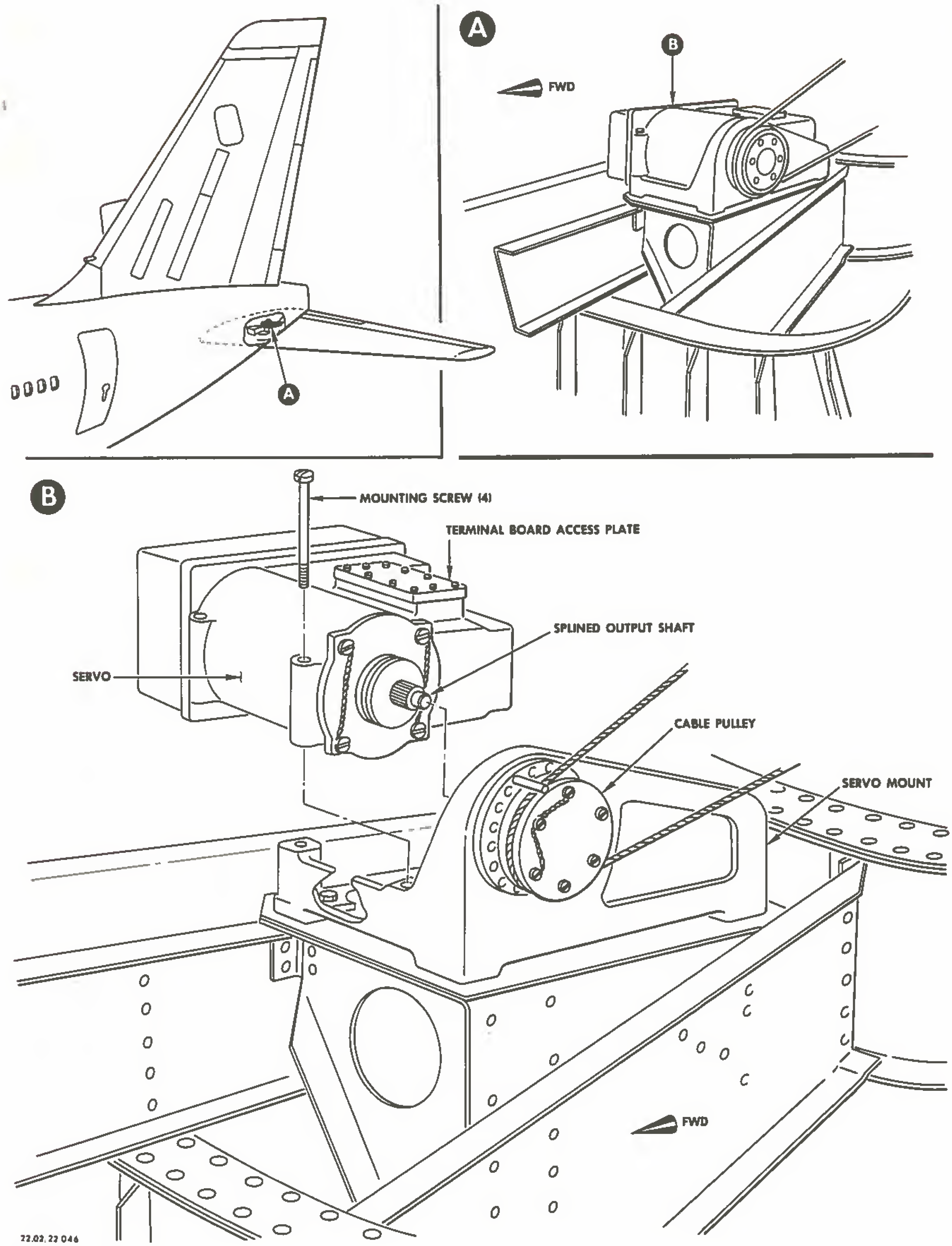
      (3) Connect and safety-wire the electrical connector.

   D. Remove Elevator Servo Mount.

      (1) Remove the elevator servo.

      (2) Disconnect the elevator servo cable from the servo mount pulley.

      (3) Remove four screws that secure the servo mount to its mounting bracket.



Elevator Servo
Figure 1

ELEVATOR SURFACE SERVO - DESCRIPTION AND OPERATION

1. Description

The elevator surface control servo is identical to the servo in the aileron control system; and the output shaft of the elevator servo connects by splines to the elevator control cable pulley in exactly the same manner that the aileron servo connects to the aileron cable control pulley. Figure 1 shows details of the elevator servo and cable installation and provides information about removal and installation procedures.

(2) Re-rig the servo control cable on the servo cable and the airplane cable pulleys. For cable rigging instructions, refer to Chapter 27, FLIGHT CONTROLS.

(3) Remove warning signs from control wheels.

(4) Close AUTOPILOT circuit breaker and remove warning sign.

(5) Test system operation, refer to 22-0, Adjustment/Test.

AILERON SURFACE SERVO - MAINTENANCE PRACTICES

1. Removal/Installation Aileron Servo (see Figure 1)

   A. Equipment Required - None.

   B. Remove Aileron Servo.

      (1) Open AUTOPILOT circuit breaker on the main circuit breaker panel in flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Post "DO NOT MOVE AIRPLANE CONTROL SURFACES" signs on the control wheels in the flight compartment.

      (3) Gain access to the hydraulic compartment.

      (4) Break the safety wire on the electrical connector. Disconnect and cap the connector.

      (5) Break the safety wires on the four mounting screws of the aileron servo and remove the four screws.

      (6) Lift the servo from the servo mount.

   C. Install Aileron Servo.

      (1) Position the aileron servo on the servo mount, engaging the splines of the servo output shaft with the splines of the cable pulley.

      (2) Install the mounting screws and safety-wire.

      (3) Connect and safety-wire the electrical connector.

   D. Remove Aileron Servo Mount.

      (1) Remove the aileron servo.

      (2) Disconnect the aileron servo cable from the pulley.

      (3) Remove four screws that secure the servo mount to its mounting bracket.

   E. Install Servo Mount.

      (1) Secure the servo mount to the mounting bracket with four screws.

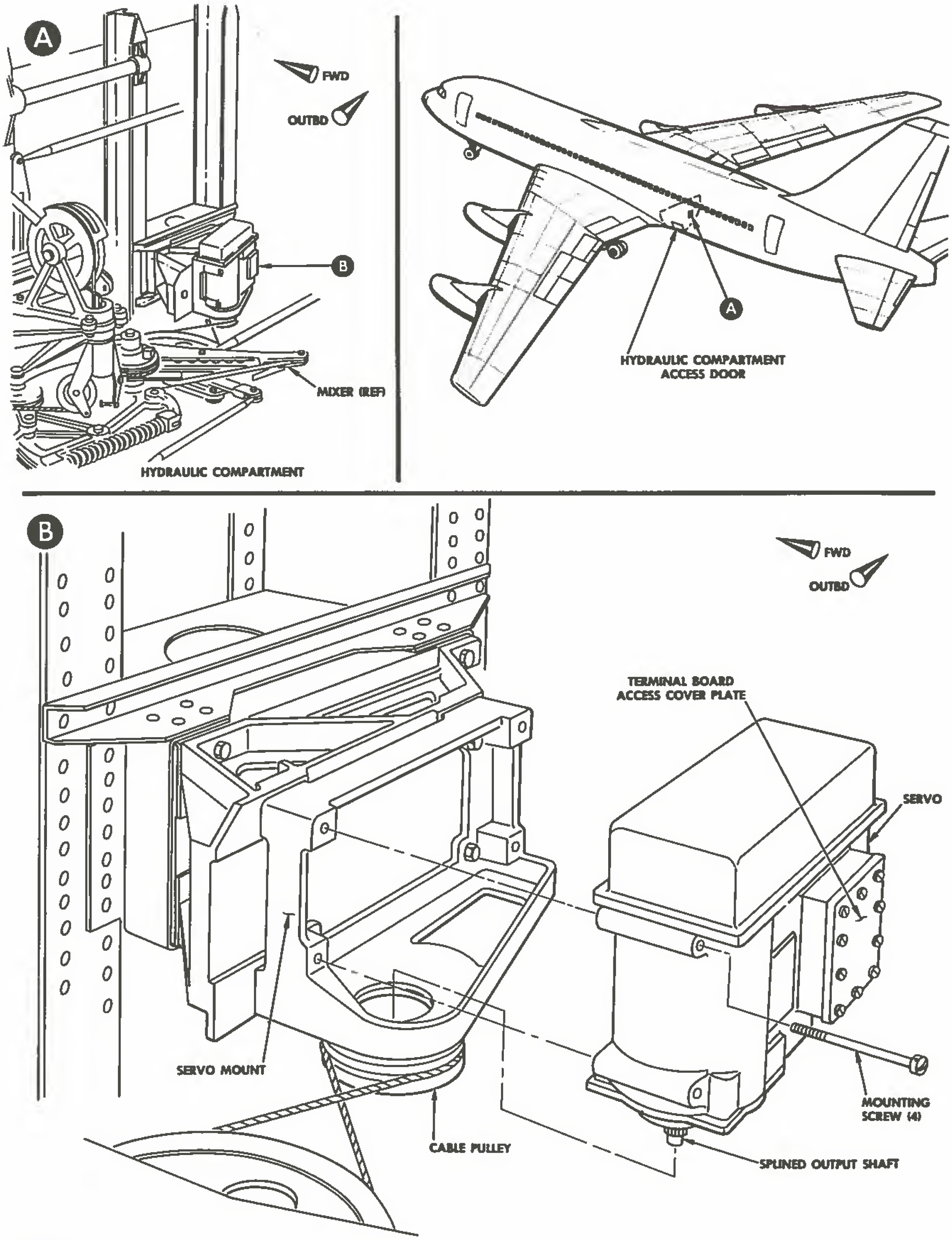
voltage readings and other measurements can be readily gained through a removable plate.

B. Electromagnetic Clutch.

The solenoid-actuated electromagnetic clutch has no sliding parts and provides on-off action only. Slip action is obtained from a multiple-disc clutch placed between the solenoid clutch output and the servo output shaft. Electromagnetic clutching action places a spring load on the multiple-disc clutch through a bellows and diaphragm arrangement. The multiple-disc clutch drives the output shaft, which is splined to the cable pulley. Clutch slip value is adjustable.

C. Torque Check.

The splined output shaft of the servo is hollow and contains a shaft that is connected to the input side of the solenoid clutch. The output end of the smaller shaft is hexagonal, allowing the attachment of a torque wrench for checking servo torque. With power on the servo and the clutch disengaged, the torque wrench reads servo torque only, not the effective torque applied at the control tab hinge. The latter torque would be servo torque less rigging friction.



Aileron Servo
Figure 1

AILERON SURFACE SERVO - DESCRIPTION AND OPERATION

1. General

The aileron servo positions aileron control surfaces in response to signals from the autopilot. A type SA-33-A1 card amplifier in the amplifier-computer unit develops a dc control signal for a type SA-40-C1 magnetic amplifier. The magnetic amplifier supplies the variable-phase voltage to drive the aileron servo. The variable-phase voltage to the aileron servo may vary from zero to 250 volts ac under the control of signals from the autopilot.

The servo consists of the following: a servo motor that drives the servo output shaft through a reduction gear train and an electromagnetic clutch; a servo mount that mounts the aileron cable pulley which the output shaft drives; a rate generator that produces a signal proportional to the speed of the servo motor shaft; and an output shaft follow-up Autosyn synchro that closes the servo loop.

The servo has adjustable torque limits. The pinion of the servo motor drives the gear train through a differential, the cage of which is spring-loaded to structure. Application of torque to the differential results in proportional movement of the differential cage. When a preset torque limit is reached, an arm of the cage actuates a microswitch in series with the fixed phase voltage supply to the servo motor and opens the circuit. The torque limit switch protects the servo mechanism by preventing the application of excessive torque. Figure 1 shows aileron servo installation details.

A. Servo Motor.

The servo motor is a 2-phase induction motor. One electrical phase, the fixed phase, is constantly excited by 115-volt, 400 cps ac power. Voltage for the second phase, the variable phase, is developed by the input signal to the servo amplifier and varies from zero to 250 volts. A capacitor across the variable phase supply adjusts the supply phase angle.

The servo motor couples through the planetary gear train to the output shaft which splines to the aileron cable pulley. The electromagnetic clutch engages the gear train to the output shaft. The servo can be removed and installed without disturbing cable rigging. Two stages of gearing in the planetary gear train give a reduction ratio of 27:1. The low speed side of the gear train drives directly into the electromagnetic clutch. Electrical connections to the servo are made through a receptacle on the servo. Access to a terminal board in the servo for

AUTOPILOT WARNING AND INDICATING LIGHTS - MAINTENANCE PRACTICES

1. Removal/Replacement Warning and Indicating Lights

   A. Equipment Required - None.

   B. Remove Lights.

      (1) Open AUTOPILOT circuit breaker on the main circuit breaker panel in flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Remove plastic covers of lights to replace lamps.

      (3) Release seven Dzus fasteners and slide engine instrument panel out from frame for access to light assemblies.

      (4) Disconnect wires and remove assemblies.

   C. Install Lights.

      (1) Install light assemblies and reconnect wires.

      (2) Slide the instrument panel into the frame and secure the Dzus fasteners.

      (3) Install lamps and plastic light covers.

      (4) Close AUTOPILOT circuit breaker and remove warning sign.

AUTOPILOT WARNING AND INDICATING LIGHTS - DESCRIPTION AND OPERATION

1. Description

A blue glide slope-armed warning light, a red elevator out-of-trim warning light, and a red autopilot-disengaged indicator light warn and inform pilots of flight situations. The lights are located at the left side of the engine instrument panel above the three-axis trim indicator.

The blue glide slope-armed light illuminates when GS AUTO position is selected on the autopilot control panel. At glide slope beam intercept the glide slope signal takes control of the airplane, the altitude engage switch automatically deactuates if it is engaged, and the glide slope-armed warning light extinguishes.

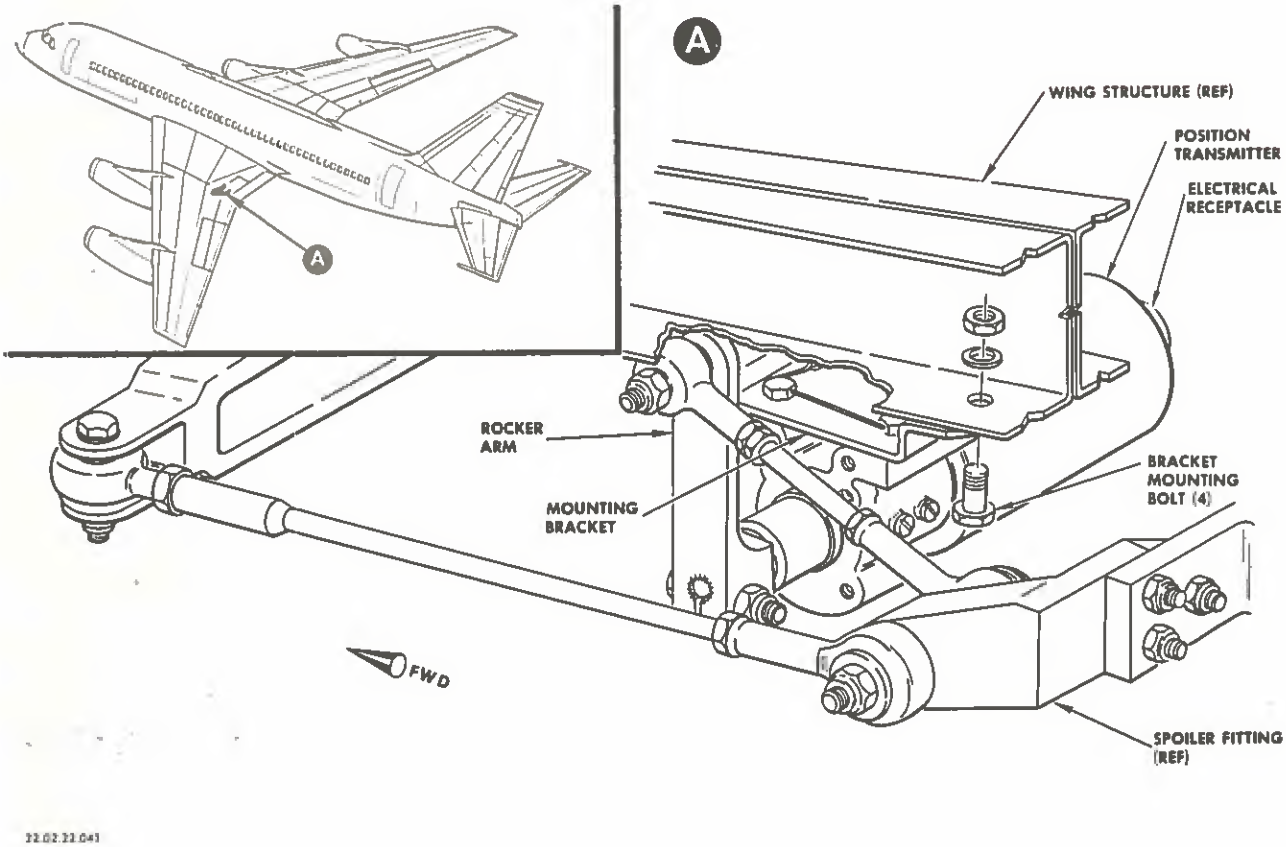
The red elevator out-of-trim warning light shows trim condition at all times and thus indicates that the stabilizer trim servo may be working against flight control signals.

The red autopilot-disengaged warning light flashes if autopilot is disengaged at the control panel, or if there is a malfunction. The light illuminates steadily if 28-volt dc power is lost or not turned on. Illumination of the warning light does not necessarily signify impairment of autopilot or damper operation. Pilots can extinguish the light by actuating the autopilot disengage switch on the control columns. Brilliance of these warning lights can be dimmed through the warning light dimming relays to adjust to lighting conditions.

(8) Remove the warning signs from the control wheels.

(9) Close AUTOPILOT circuit breaker and remove warning sign.

(10) Test system operation, refer to 22-0, Adjustment/Test.



Spoiler Position Transmitter,
Installation Details
Figure 201

POSITION TRANSMITTERS - MAINTENANCE PRACTICES

1. Removal/Installation Position Transmitters (see Figure 201)

   A. Equipment Required - None.

   B. Remove Position Transmitter.

      (1) Open the AUTOPILOT circuit breaker on the main circuit breaker panel in the flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Post "DO NOT MOVE AILERONS" signs on the control wheels in the flight compartment.

      (3) Open inboard spoiler access doors in underside of the wings.

      (4) Disconnect electrical connector from inboard end of transmitter.

      (5) Disconnect rocker arm from outboard end of transmitter.

      (6) Remove four bolts that secure transmitter mounting bracket to wing structure. Retain the bolts and nuts for reinstallation.

      (7) Cap the electrical cable connector and the transmitter receptacle.

   C. Install Position Transmitter.

      (1) Bolt a mounting bracket to the transmitter, if the bracket is not already installed.

      (2) Secure the transmitter mounting bracket to the wing structure with four bolts and nuts.

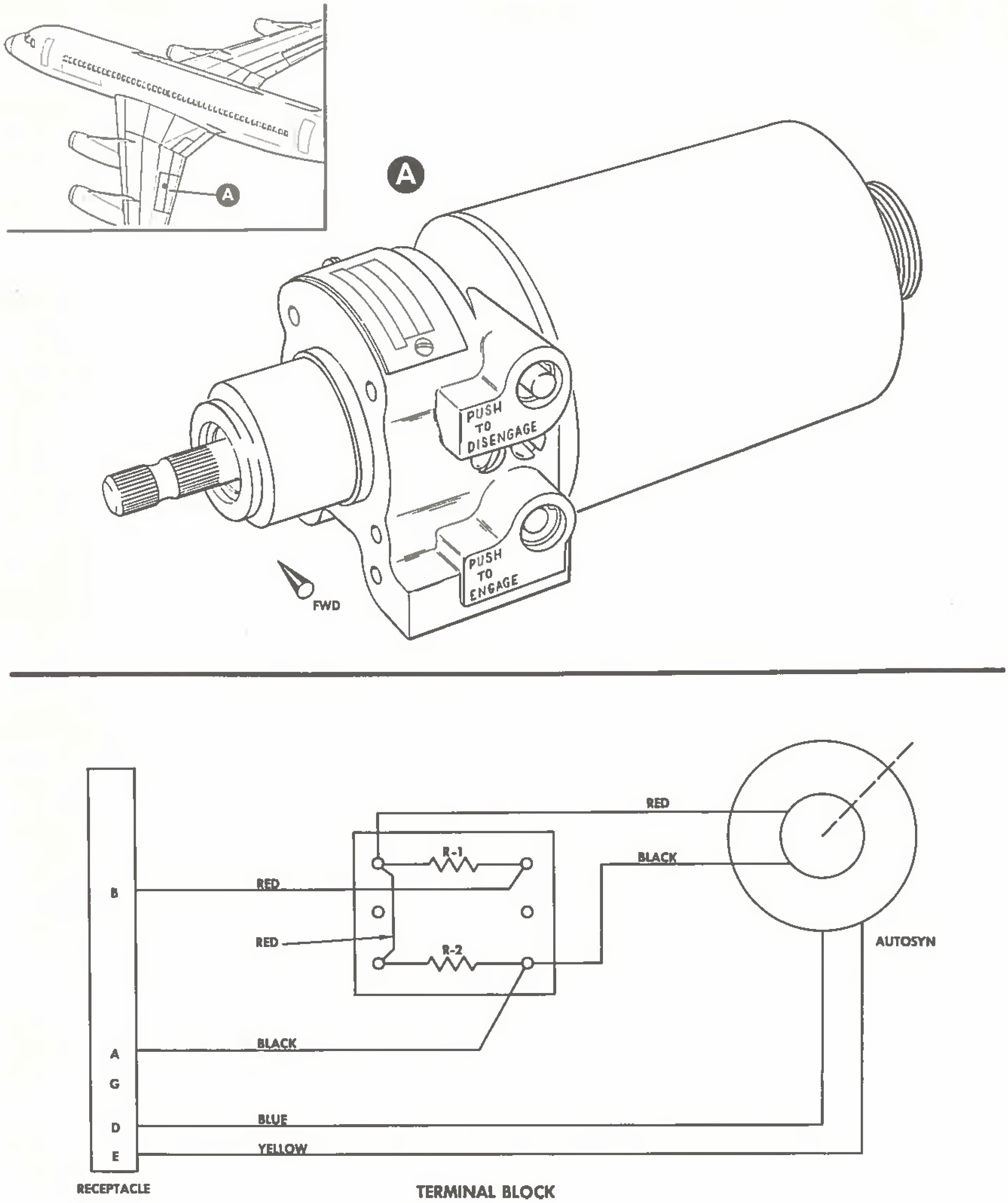
      (3) Connect electrical cable connector to the transmitter.

      (4) Secure rocker arm to the splined shaft of the transmitter.

      (5) Push disengage button on the transmitter.

      (6) Make sure that spoilers are down and that ailerons are in neutral position.

      (7) Press engage button on the transmitter and safety-wire the button into engaged position.



Spoiler Position Transmitter
Figure 1

POSITION TRANSMITTERS - DESCRIPTION AND OPERATION

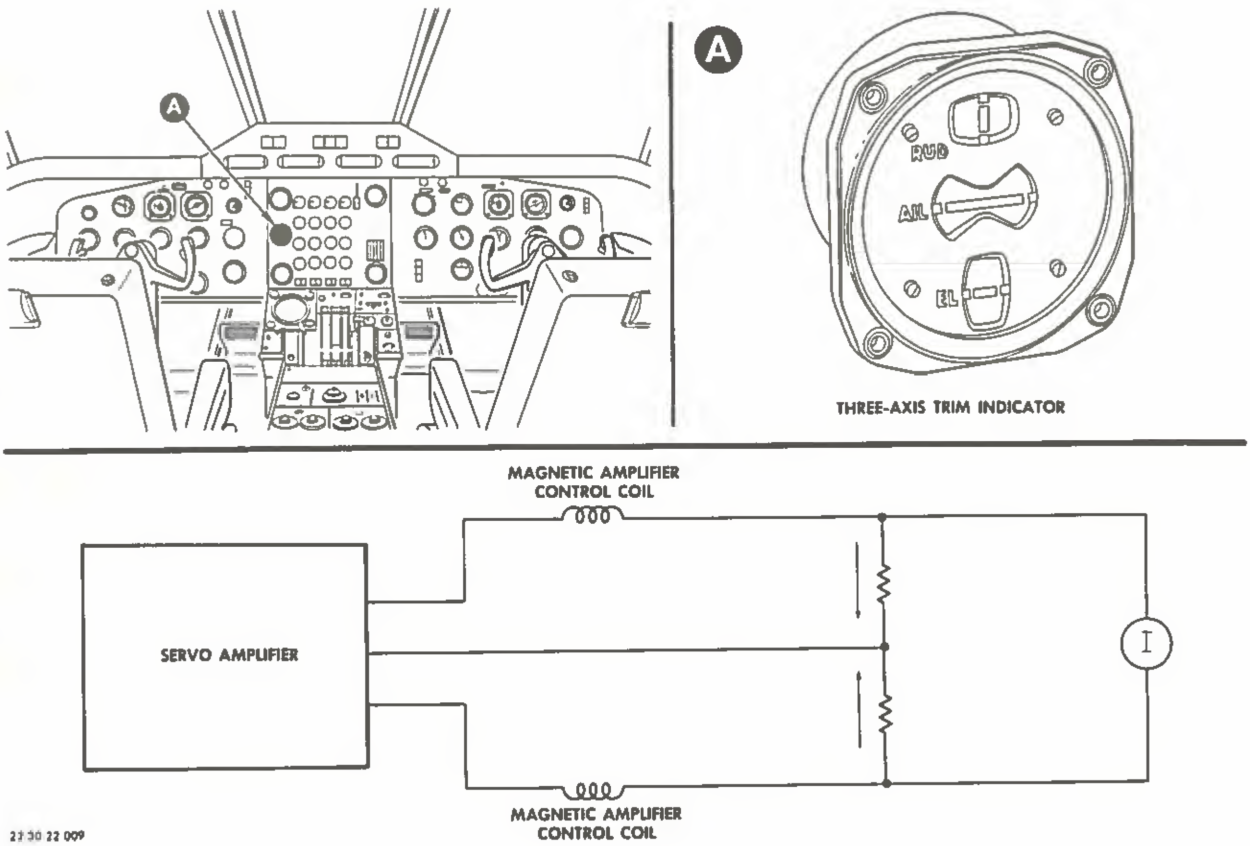
1. Description

Synchro position transmitters provide signal voltages that represent the amount of displacement of right and left spoilers from reference position. Spoilers are mechanically linked by a clutch to the splined input shaft of the synchro transmitter. Two external push rods on the transmitter unit engage and disengage the clutch. When the PUSH-TO-ENGAGE rod is depressed, the linkage between spoilers and the position transmitter is complete. When the PUSH-TO-DISENGAGE rod is depressed, the clutch disengages and the synchro motor is held at reference point. Synchro windings are excited by 26-volt, 400 cps ac power. The output signals of the synchro transmitters, which are proportional to the amount of spoiler displacement from reference point, are fed to the amplifier and computer unit of the autopilot system.

The clutch in the position transmitter linkage simplifies the matching of spoiler position with zero electrical signal at the time of installation. After matching, engage the clutch and safety-wire the PUSH-TO-DISENGAGE rod to prevent clutch disengagement. The transmitter then operates as though it were directly connected to the spoilers.

The spoiler transmitters are installed near the center of the inboard spoilers. Rocker arms link spoiler movement to the shafts of the transmitters. The transmitters are mounted on brackets that are secured to the wing structure. An electrical connector on each transmitter makes electrical connections to the autopilot system. See Figure 1 for an illustration of the position transmitters.

Instructions for removal and installation of the three-axis trim indicator are provided in Chapter 31, INSTRUMENTS. The AUTOPILOT circuit breaker on the main circuit breaker panel in the flight compartment must be opened before the electrical connector of the indicator is disconnected.



Three-Axis Trim Indicator
Figure 1

THREE-AXIS TRIM INDICATOR - DESCRIPTION AND OPERATION

1. Description

A trim indicator on the instrument panel provides visual indication of out-of-trim condition in all three axes. The trim indicator operates when the associated amplifiers are driving the servos, whether the autopilot is engaged or not.

The indicator consists of a bezel-mounted case containing a meter movement for each airplane control surface. The movements are similar to the movements of electrical indicating instruments. The case is gasket-sealed and airtight. Electrical connections are made through receptacles on the rear of the indicator. Figure 1 shows an illustration of the indicator and a schematic of meter movement control circuits.

Rudder out-of-trim condition is indicated by right or left deflection of a vertical white index bar from index marks in the upper window of the indicator; aileron out-of-trim is indicated by tilting of a horizontal white bar in the center window; and elevator out-of-trim is indicated by upward or downward deflection of a horizontal white bar in the lower window. Under manual control the control surfaces would normally be trimmed manually to reduce dynamic forces on the pilots' controls. When the autopilot is energized the flight path is maintained despite out-of-trim condition. But if a steady-state out-of-trim condition is indicated with the autopilot engaged, the control surfaces should be trimmed to the correct indication.

2. Signal Sources for Trim Indicator

Servo amplifiers in rudder, aileron, and elevator control channels act as control stages for magnetic amplifier power stages. The servo amplifiers supply current to two magnetic amplifier control coils in each control surface channel. A signal on a servo amplifier causes increasing current in one control coil and decreasing current in the other. Indicator meter movements are connected across the outputs of the magnetic amplifier control coils. The direction and magnitude of current flow through the control coils determine the direction and amount of trim indicator deflection. Thus if a servomotor is applying torque, the corresponding trim indicator is displaced.

Transient loads cause momentary displacements of the trim indicator index bars. A sustained out-of-trim indication should be corrected for by trimming the corresponding surface manually. Deflection of the trim index to the right, for example, means that the rudder should be trimmed to bring the nose of the airplane to the right; a right wing down indication of the aileron trim indicator means that trim should be adjusted to bring the right wing down.

AUTOPILOT ADAPTER - MAINTENANCE PRACTICES

1. Removal/Installation Autopilot Adapter (see Figure 1)

   A. Equipment Required - None.

   B. Remove Autopilot Adapter.

      (1) Open the AUTOPILOT circuit breaker on the main circuit breaker panel in the flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Gain access to the equipment rack at the forward left side of electrical compartment.

      (3) Disconnect and cap the electrical connector of the adapter.

      (4) Remove three screws securing the adapter to the center supporting structure of the equipment rack. Retain the screws for reinstallation.

      (5) For access to the adapter potentiometer adjustments, remove four screws that hold bottom plate of the adapter.

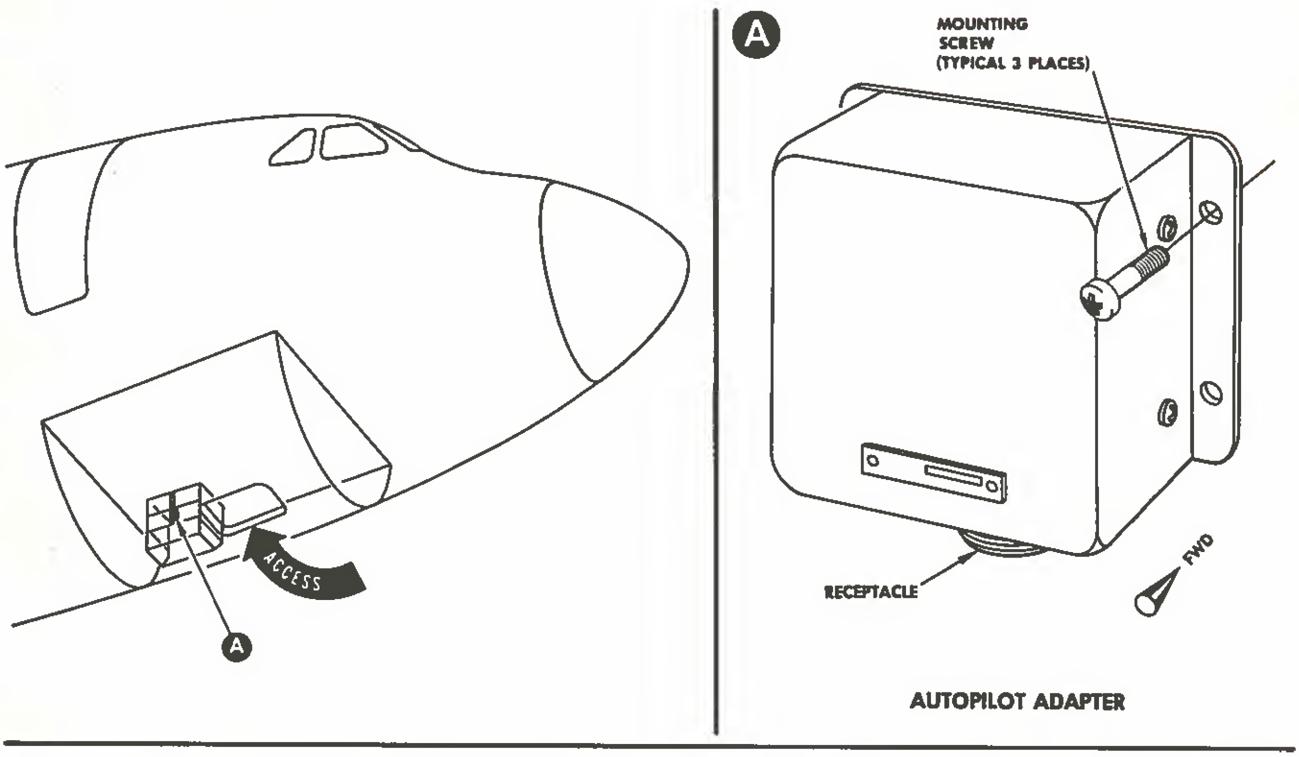
   C. Install Autopilot Adapter.

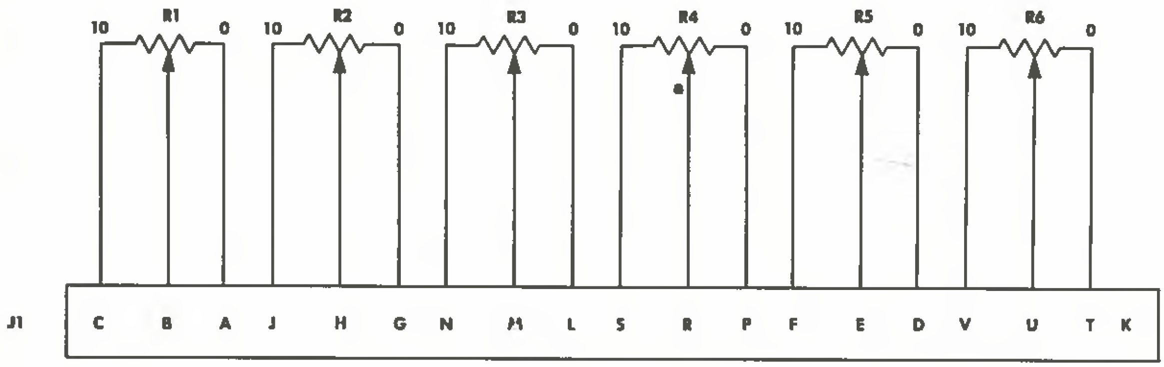
      (1) Secure the adapter to the center supporting structure of the electrical compartment equipment rack by four screws.

      (2) Connect and safety-wire the electrical connector.

      (3) Close AUTOPILOT circuit breaker and remove warning sign.

      (4) Test system operation, refer to 22-0, Adjustment/Test.





SCHEMATIC SYMBOL	DESCRIPTION	FUNCTION
R1	10,000 OHMS 2W	POTENTIOMETER
R2	10,000 OHMS 2W	POTENTIOMETER
R3	10,000 OHMS 2W	POTENTIOMETER
R4	10,000 OHMS 2W	POTENTIOMETER
R5	10,000 OHMS 2W	POTENTIOMETER
R6	10,000 OHMS 2W	POTENTIOMETER
J1	19 PINS, MALE	RECEPTACLE

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Autopilot Adapter
Figure 2

AUTOPILOT ADAPTER - DESCRIPTION AND OPERATION

1. Description

The autopilot adapter is installed on the center supporting structure of the equipment rack in the forward left side of the electrical compartment. The autopilot adapter contains six potentiometers that are set to adjust autopilot gain in accordance with flight characteristics of the airplane. Adjustments are made and the controls are locked at installation. The potentiometers are made accessible for adjustment, inspection, and repair by removing the bottom plate of the adapter unit. The adapter must be removed from the mounting base for access to the bottom plate. Figure 1 shows an illustration and a schematic diagram of the autopilot adapter.

The correct settings of autopilot adapter potentiometers are as follows (100% setting being full clockwise rotation of the screw driver-adjusted potentiometer shaft):

	POT. NO.	SETTING	
	1	85%	
AIL. FU	2	85%	followup
ELEV. FU	3	75%	
	4	100%	
	5	100%	
	6	100%	

NOTE: Do not interchange the hoses. The larger inboard line to the bulkhead fittings is the static line.

(6) Close AUTOPILOT circuit breaker and remove warning sign.

(7) Test system operation. Refer to 22-0, Adjustment/Test.

AIR DATA SENSOR - MAINTENANCE PRACTICES

1. Removal/Installation Air Data Sensor (see Figure 1)

   A. Equipment Required - None.

   B. Remove Air Data Sensor.

      (1) Open AUTOPILOT circuit breaker on the main circuit breaker in the flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Gain access to the equipment rack in the forward left side of the electrical compartment.

      (3) Disconnect and cap the flexible pitot and static hoses to the air data sensor. Cap the hose fittings on the air data sensor.

      (4) Unscrew two captive screws, disconnect the electrical plug, and cap both plug and receptacle.

      CAUTION: TO PREVENT DAMAGE TO PLUG AND/OR RECEPTACLE, UNSCREW THE TWO CAPTIVE SCREWS BY ALTERNATELY LOOSENING EACH SCREW UNTIL BOTH SCREWS ARE FREE.

      (5) Using a socket wrench, loosen the hexagonal-headed screw in the center of the rack below the air data sensor.

      (6) Lift the air data sensor slightly and withdraw it from the vibration mount.

   C. Install Air Data Sensor.

      (1) Position the air data sensor on the vibration mount and engage the guide pins at the rear of the mount.

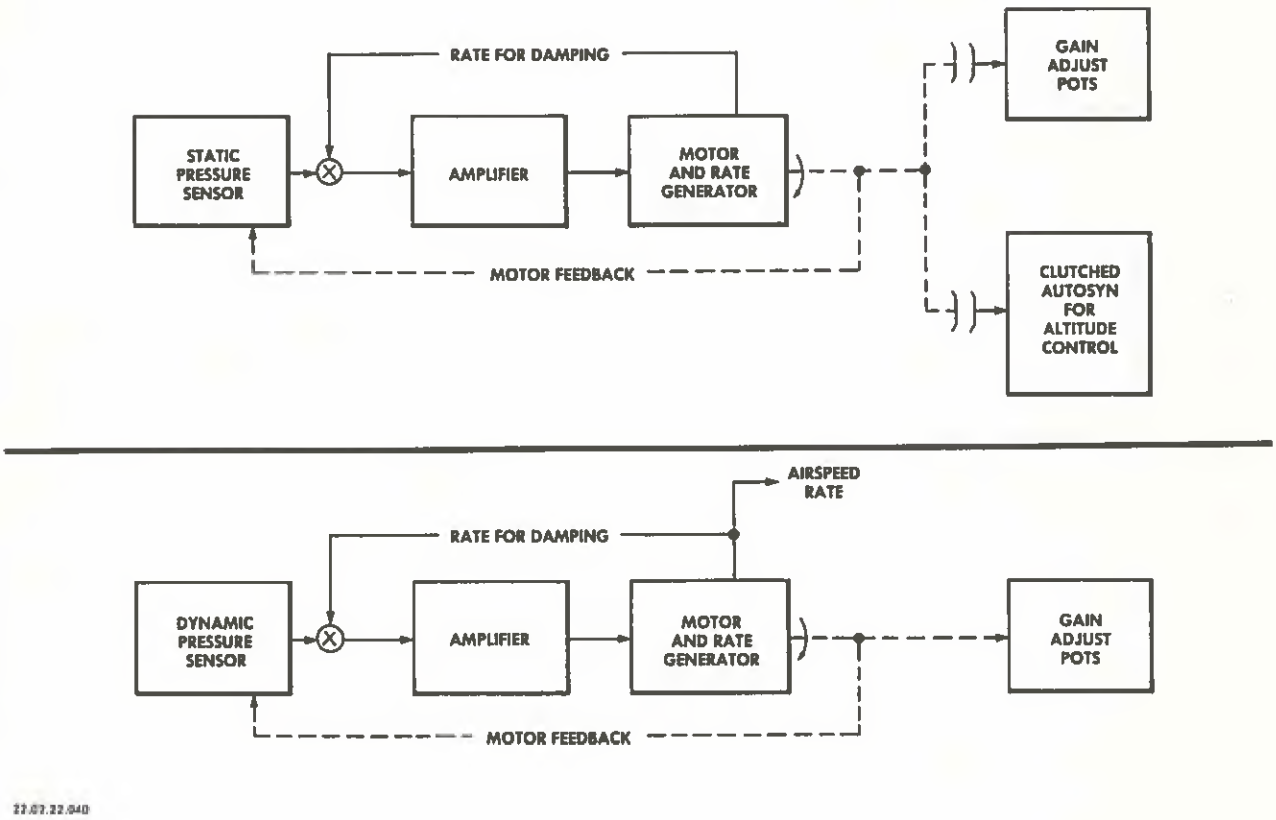
      (2) Tighten the hexagonal-head screw in the center of the mount.

      (3) Connect the electrical connector.

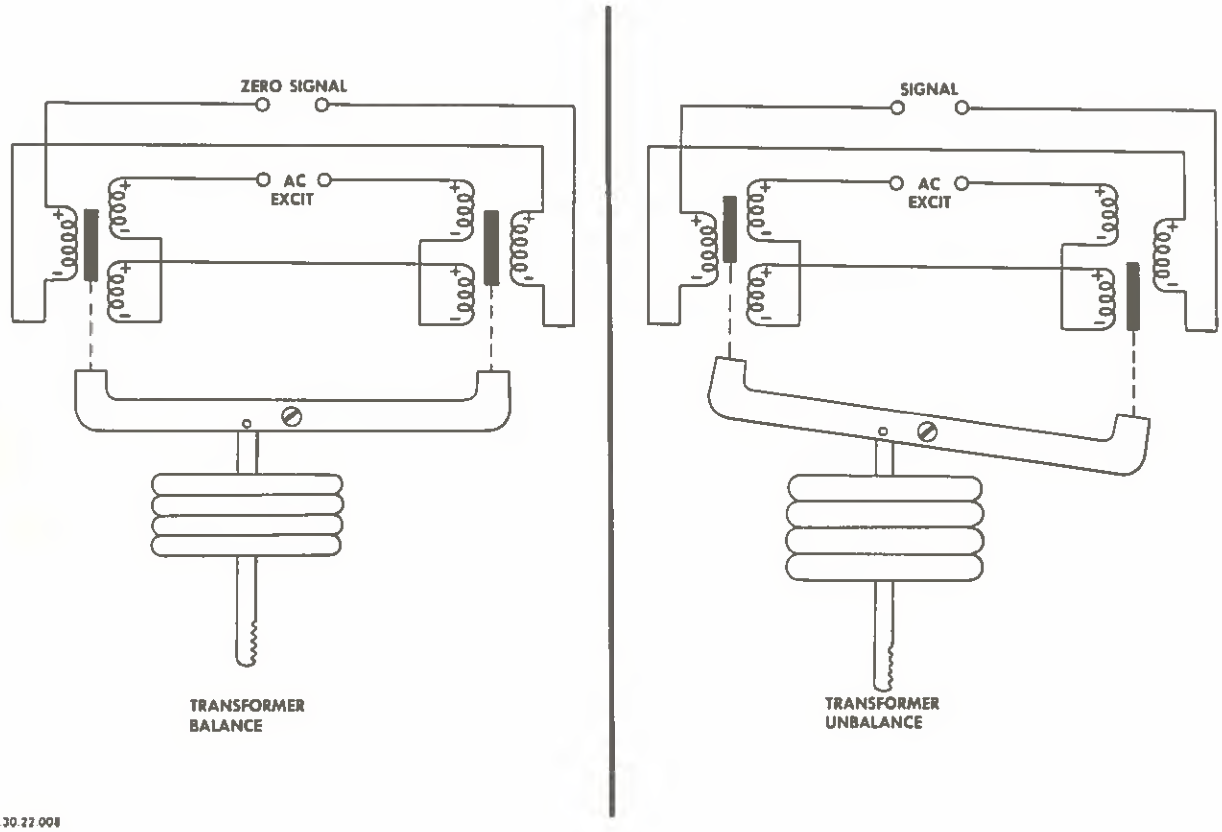
      CAUTION: TO PREVENT DAMAGE TO PLUG AND/OR RECEPTACLE, SCREW DOWN THE TWO CAPTIVE SCREWS BY ALTERNATELY TIGHTENING EACH SCREW UNTIL THE CONNECTOR IS FIRMLY SEATED.

      (4) Leak-test the pitot and static systems. Refer to Chapter 34, NAVIGATION, Section 34-9-0 for instructions.

      (5) Connect the pitot and static hoses to the air data sensor.



Air Data Sensor Pressure Control,
Block Diagram
Figure 3



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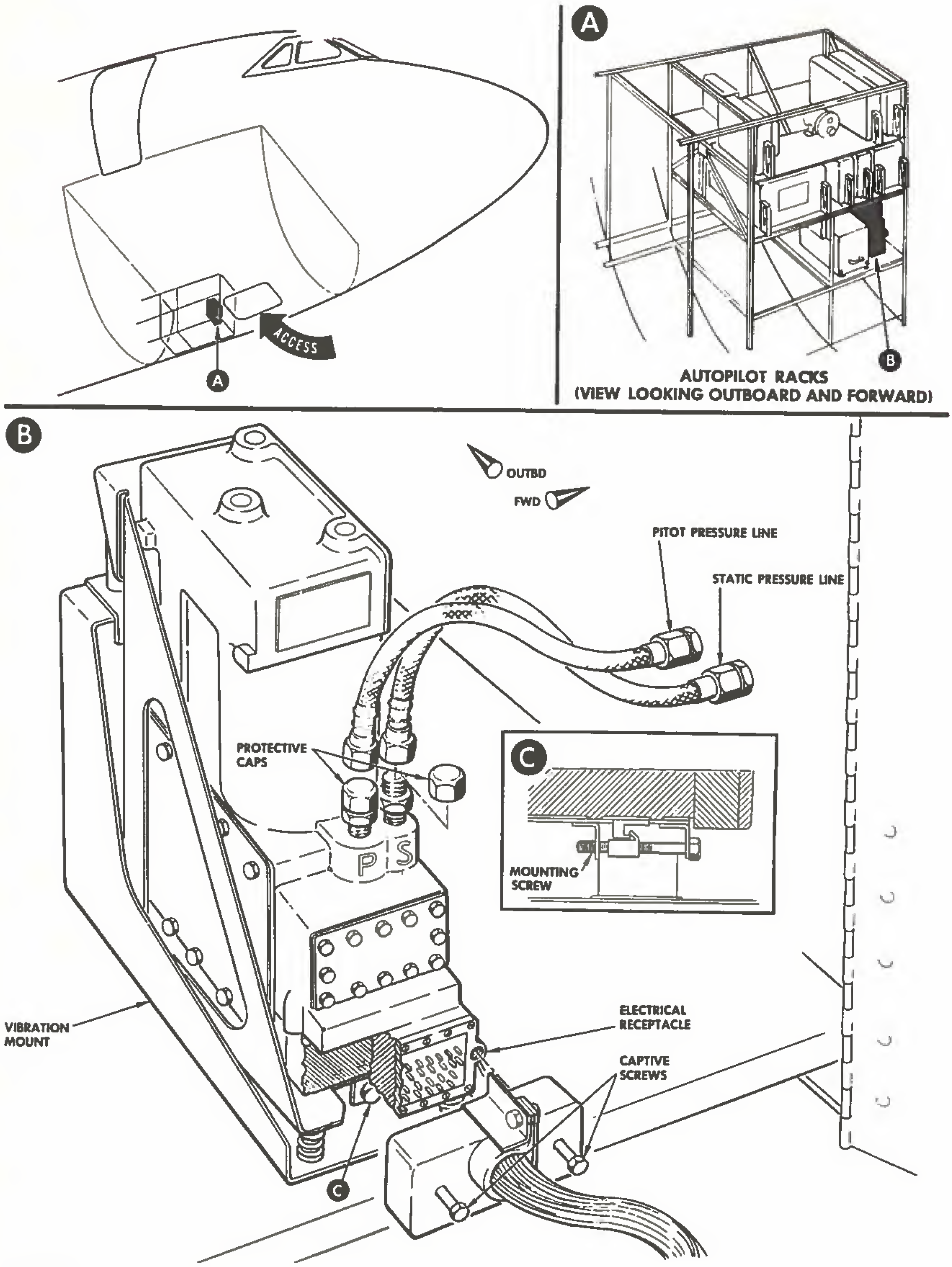
Signal Generation in Air Data Sensor,
Schematic Diagram
Figure 2

2. Operation

The Schaevitz coils are linear differential transformers. Rocker arm movement simultaneously varies core movement within two transformers in the airspeed sensor and within four transformers in the altitude sensor. Two input windings in each transformer are excited by alternating current. The input windings are connected in opposed phase, so that displacement of the magnetic cores produces differential voltage output. Two transformers double the output signal voltage, four quadruple the output voltage, thus increasing amplifier gain. Figure 2 shows how signals are generated in the air data sensor.

The electrical signals are amplified by card amplifiers in the amplifier-computer and are then applied to motor and rate generator servos in air data sensor. Operation is similar in the two sections. Movement of the diaphragm drives the motor in the direction that nulls the signal voltage. The position at which the motor comes to rest provides an indication of diaphragm pressure at any instant.

The servo motors are linked to the potentiometer wiper arms. In this way the potentiometers are positioned as functions of altitude and airspeed. Localizer and glide slope signals are attenuated by these potentiometers by an amount proportional to altitude; and surface control signals are attenuated in accordance with airspeed. Figure 3 shows how the air data sensor pressure sensors control gain by adjusting the potentiometers. Figure 4 is a schematic diagram of the air data sensor.



Air Data Sensor
Figure 1

AIR DATA SENSOR - DESCRIPTION AND OPERATION

1. General

The air data sensor is a precision instrument that senses static (ambient) and dynamic (ram) air pressures and converts them into electrical signals that are used by the autopilot system for airplane control. Figure 1 shows an illustration of the air data sensor.

Pressure is sensed by a sealed aneroid diaphragm in the static section. Ram air from a pitot tube is conducted to the interior of a diaphragm in the dynamic section. This diaphragm expands and contracts as airspeed increases and decreases respectively. Static air is ducted to the airtight cases of both sections. The air data sensor thus senses altitude and airspeed.

The diaphragms are mechanically linked to rocker arms that displace magnetic cores in special Schaevitz transformers as the diaphragms expand and contract. Displacement of the transformer core material varies the inductance of the transformers.

Spring-loaded override devices in the mechanical linkages of the diaphragms open the linkage when large pressure changes occur suddenly or when changes exceed the dynamic limits of the instrument. The linkage become operative again as soon as the cause of the override ceases.

Overtravel return mechanisms drive the air data sensor unit back to within its normal range when upper or lower preset limits are exceeded. The return mechanisms consist of pairs of single-pole, double-throw miniature switches and double-secondary, center-tapped transformers. The unit oscillates about the limits until the cause of overtravel is removed. The unit is self-synchronizing and returns to normal operation after the oscillations cease.

A. Vibration Mount.

The air data sensor is installed on a special double-rack vibration mount in the equipment rack at the forward left side of the electrical compartment. The unit is attached to an inner mount supported by an outer mount on metallic vibration insulators.

B. Air Data Sensor Connections.

Pitot and static pressure tubing terminate at fittings on the bulkhead at the forward side of the equipment rack. Flexible hoses connect the pitot lines to the pressure inlets of the air data sensor. Electrical connections to the air data sensor are made through a large rectangular connector at the bottom inboard side of the unit. The plug is secured to the air data sensor receptacle by two captive screws.

THREE-AXIS RATE CONTROL - MAINTENANCE PRACTICES

1. Removal/Installation Three-Axis Rate Control

   A. Equipment Required - None.

   B. Remove Three-Axis Rate Control.

      (1) Open AUTOPILOT circuit breaker on the main circuit breaker in the flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Disconnect the electrical connector from the three-axis rate control.

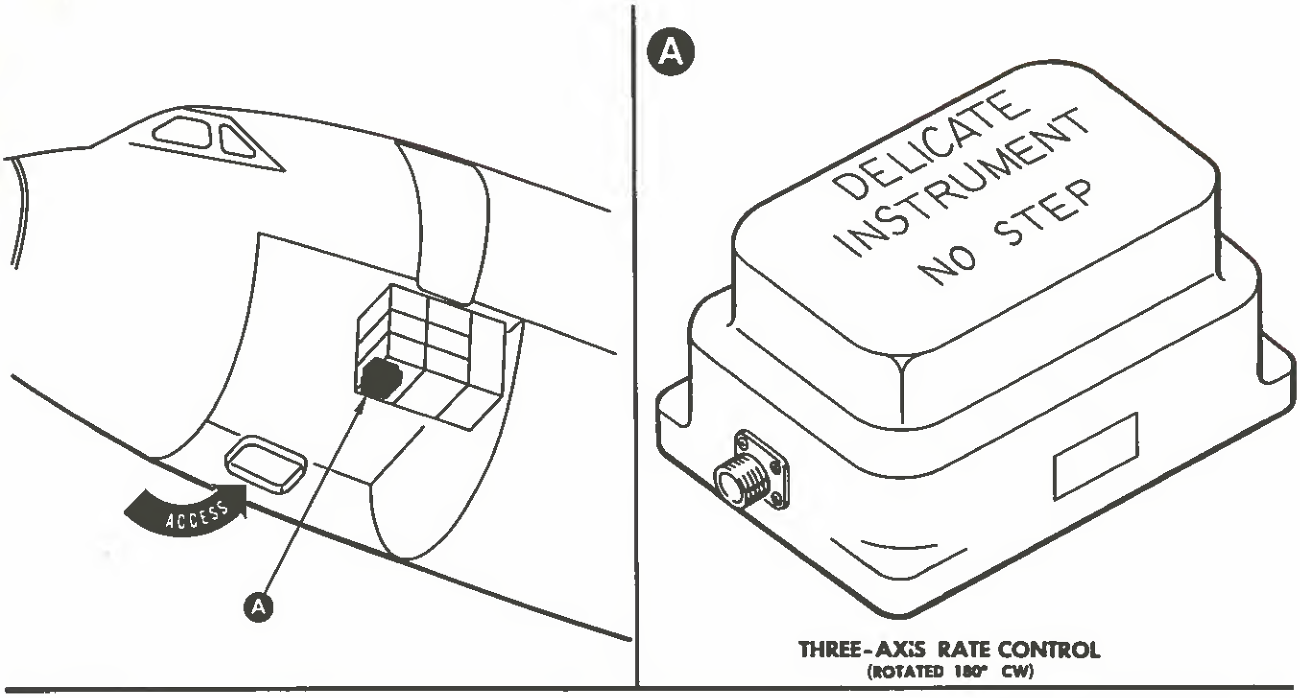
      (3) Remove four bolts that secure the unit to its mount and remove the unit.

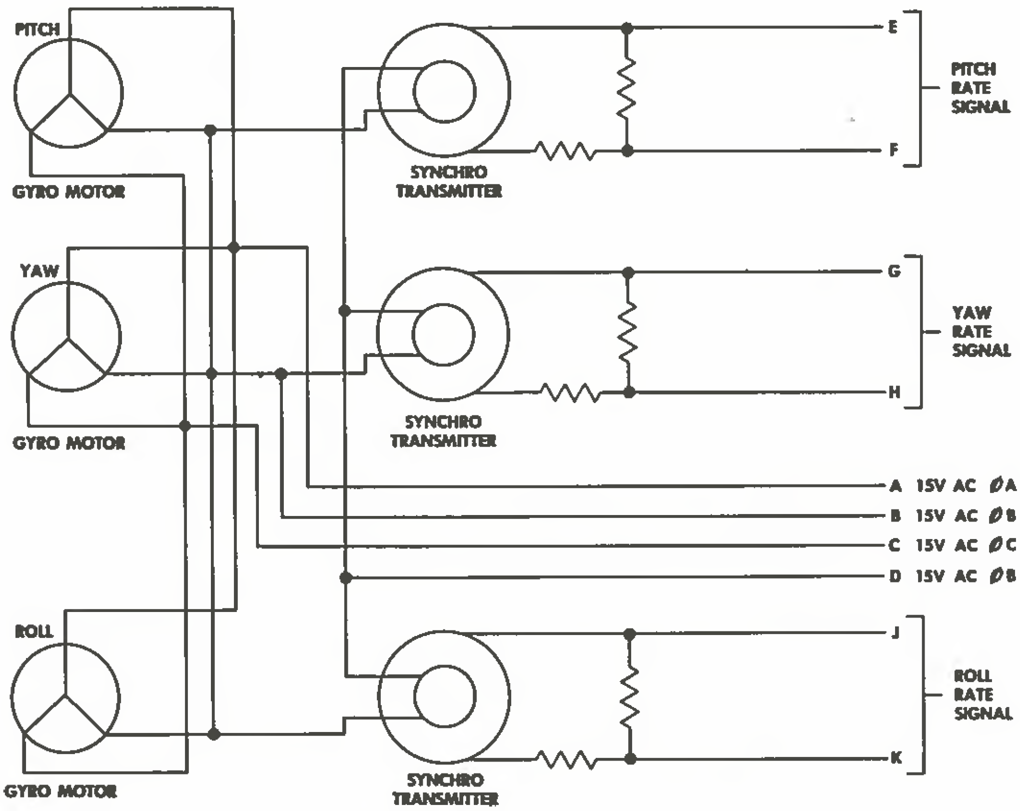
   C. Install Three-Axis Rate Control.

      (1) Position the unit on its mount, install the four base bolts, and connect the electrical connector.

      (2) Close AUTOPILOT circuit breaker and remove warning sign.

      (3) Test system operation, refer to 22-0, Adjustment/Test.





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Three-Axis Rate Control
Figure 1

THREE-AXIS RATE CONTROL - DESCRIPTION AND OPERATION

1. Description

A. Gyro Motors.

The three-axis rate control unit contains three gyro-controlled transmitters that supply the autopilot system with information about rate of change of direction in the three principal axes of the airplane. The three gyros are mounted at right angles to each other and are installed so that one gyro is parallel to each axis of the airplane. Turning movements about an axis cause the gyro in that axis to precess. The amount of precession is proportional to the turn rate. This turn rate information is transmitted to the computer-amplifier for use in the system. Figure 1 shows an illustration of the three-axis rate control.

Gyros precess against spring-loading by a spiral spring attached to the precession axis. When the turning force that causes precession is removed, the spring returns the gyro to its static position. Small piston and cylinder dashpot assemblies are linked to the gyros to damp gyro movements caused by vibration and small accelerations. A small opening in the cap of the cylinder controls movement of the piston by allowing air to slowly leak out of, or enter, the cylinder.

Precession is the characteristic of a gyro that causes the spin axis of a spinning gyro to move at right angles to the direction in which a force is applied to the gyro. For example, if the gimbals of a gyro are fixed in a fore and aft direction in an airplane so that tipping movements only of the gyro are permitted, yawing to right or left causes the gyro to tip up or down; that is, movements of the gyro are at right angles to the turning force applied. A gyro mounted in a vertical position tips fore and aft when the airplane rolls. These precession movements are converted into rate of turn signals by transmitters on the gimbals of the gyros.

B. Autosyns.

An Autosyn signal transmitter is installed on the gimbal of each of the three-axis gyros. Precession of the gyros causes turning movement of Autosyn rotors. This movement is converted into electrical signals as the airplane turns about its axes. The amount of Autosyn rotor rotation is proportional to the turning rate. Autosyn outputs are converted to 2-wire outputs. The windings of the Autosyns are energized by 26-volts ac, 400 cps.

G. "Versine" Signal Generation.

The Autosyn synchro, in the roll gimbal of the vertical gyro, provides signals that vary as the sine and cosine of the bank angle of the airplane. The sine function output increases from zero to maximum as the bank angle increases from level flight to 90 degrees of bank. The cosine function output is maximum in level flight and decreases to zero as the airplane banks to 90 degrees. The sine function gives the bank attitude signal for autopilot operation. The "versine" signal is derived from the cosine function of the angle of bank. This "versine" signal provides up-elevator commands during turns to compensate for the tendency of the airplane to lose altitude in a turn. "Versine" signals are fed into the elevator channel servo loop as shown in Figures 7 and 103, Section 22-0.

D. Erection Amplifier System. No data available.

E. Time Delay Relays and Gyro Brake.

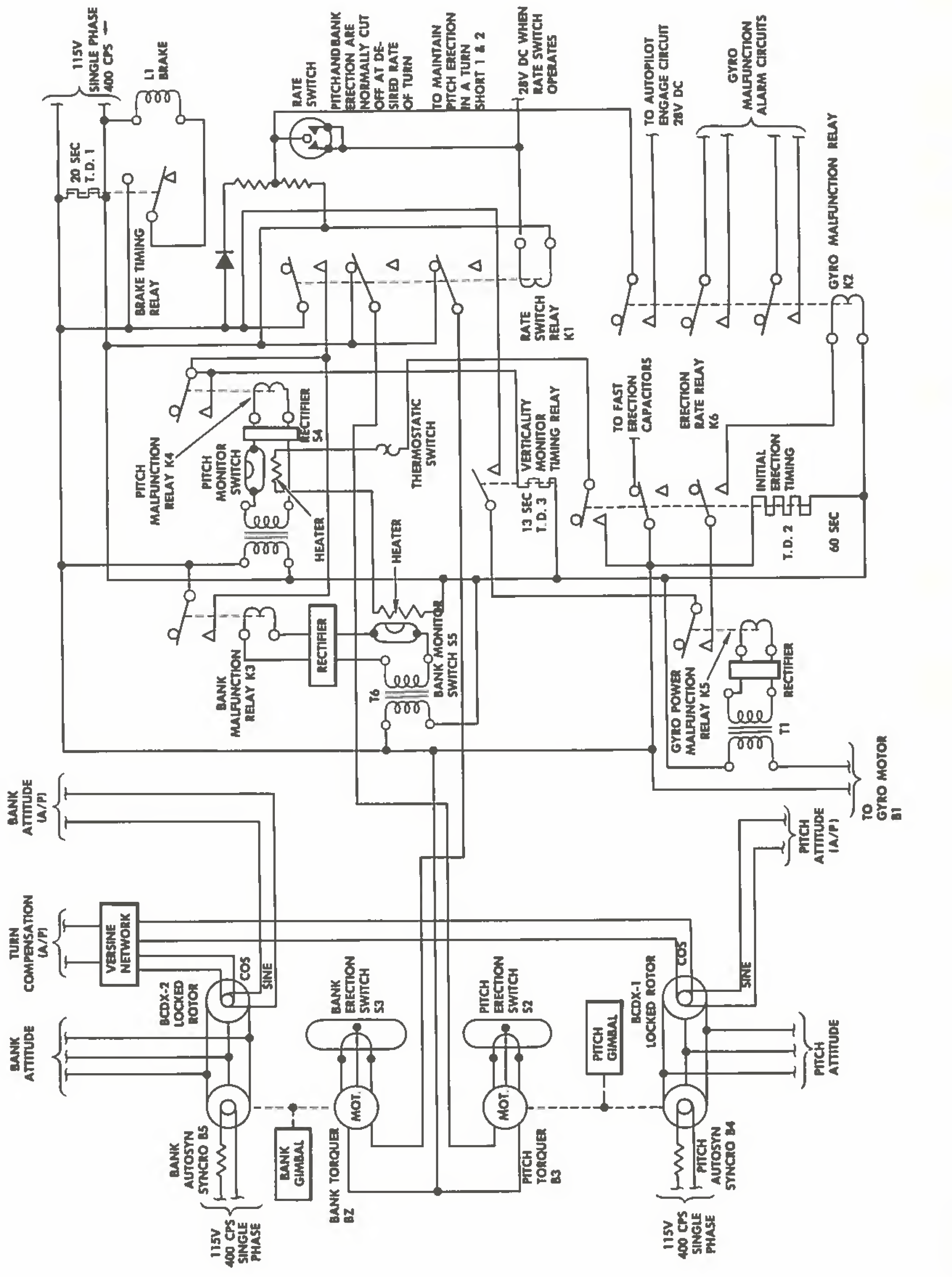
Time delay relays TD1 and TD2 start their timing cycles of 20 and 60 seconds respectively when power is applied to the vertical gyro. The gyro spin motor starts, and locked Autosyn synchros BCDX-1 and BCDX-2 energize (see Figure 2). Current flows through transformer T1 and energizes relay K5. The rate switch gyro is also energized. Erection torquers B2 and B3 start fast gyro erections to vertical through electrolytic switches S2 and S3.

When the pitch gimbal of the vertical gyro reaches five degrees of vertical, electrolytic switch S4 conducts and relay K4 energizes. When the bank gimbal reaches seven degrees of vertical, electrolytic switch S5 conducts and relay K3 energizes. Contacts of energized relays K3 and K4 pass 115-volts ac to time delay relay TD3, which starts a 13-second heating cycle. When relay TD3 energizes, power circuit is completed through contacts of relays K5 and K6. At the end of 20 seconds, time delay relay TD1 energizes solenoid L1, which releases the brake on the bank axis gimbal. At the end of 60 seconds, time delay relay TD2 energizes, opening relay K6, which removes fast erection power and completes the circuit to energize relay K2. Relay K2 contacts then close and remove the warning signal on the instrument panel.

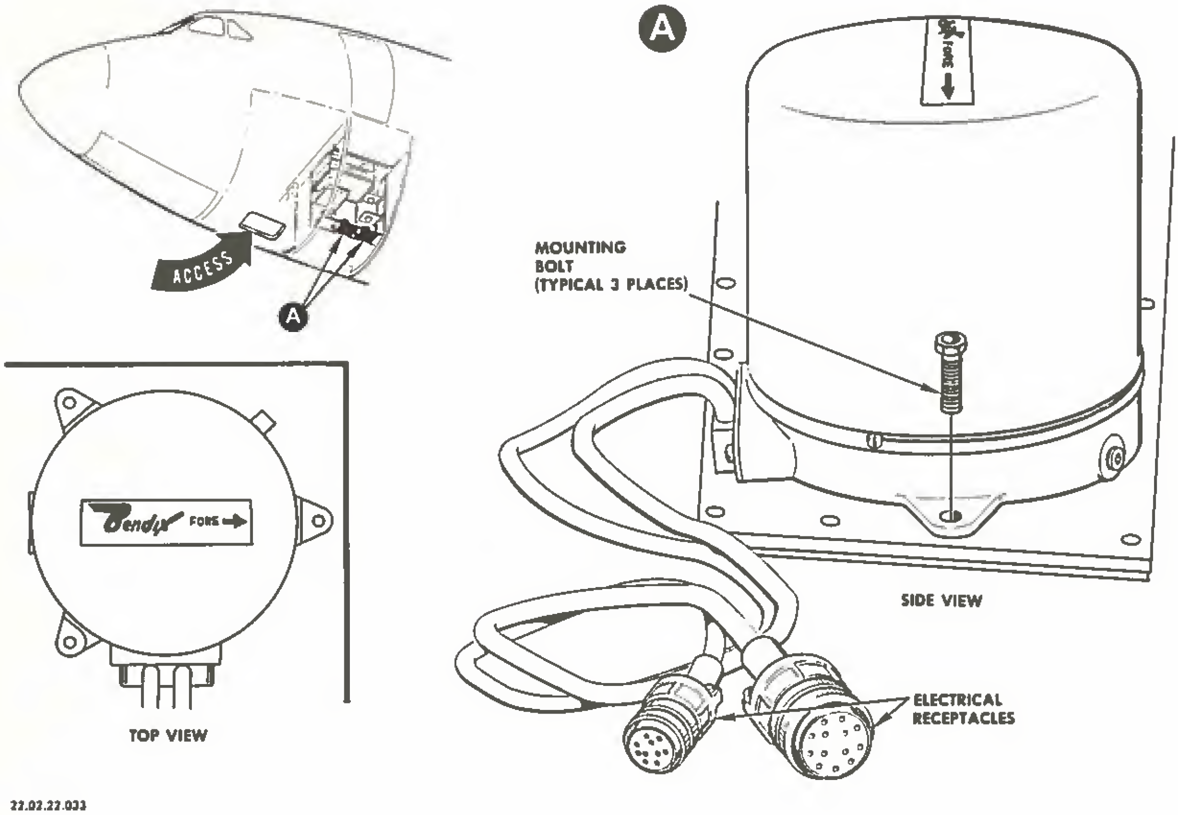
In a coordinated turn exceeding a bank angle of seven degrees, two things occur: (1) electrolytic switch S5 becomes nonconducting and removes power from time delay relay TD3, which then de-energizes in 40 seconds; (2) the turn rate switch closes with 30 seconds, energizing relay K1. The contacts of K1 cut off pitch and bank erection power and supply 115 volts to relay TD3. If gyro spin motor power fails, relay K2 de-energizes and the power warning flag on the instrument panel gives the alarm.

F. Electrolytic Switches.

Electrolytic switches are sealed tubular units that contain electrolytic fluid in which the electrodes are immersed when the gyro is erect. Opposing electrical currents flow in motor circuits controlled by the switches. When a gyro tips so that an electrode is no longer in the electrolyte, current in the remaining circuit energizes the erecting motor and erects the gyro by applying torque in the correct direction. Another electrolytic switch removes power when the bank angle of the airplane is greater than seven degrees.



Vertical Gyro Transmitter, Simplified Schematic
Figure 2



Vertical Gyro Transmitter
Figure 1

VERTICAL GYRO TRANSMITTER - DESCRIPTION AND OPERATION

1. Description

A. Gyro Motor.

The vertical gyro transmitter provides vertical reference signals for the autopilot system. The gyro is free to rotate 360 degrees about the roll axis of the airplane and plus or minus 85 degrees in the pitch axis. The gyro spin motor is a capacitor-start type and operates from single-phase, 115-volt, ac 400 cps power. The gyro spins at about 22,000 rpm. Figure 1 illustrates the vertical gyro. Figure 2 shows a simplified schematic of the vertical gyro transmitter.

B. Torque Motors.

Two hysteresis torque motors erect the gyro in the pitch and roll axes. Electrolytic switches control the application of electrical power to the torque motors and control the torquing rate so that the rate of gyro erection is proportional to gyro displacement from vertical between zero and 0.5 degree. Beyond 0.5 degree displacement the torquing rate is about two degrees per minute. Initial quick erection of the gyro is automatically controlled by internal switching, thus making caging unnecessary. The gyro is erect and ready for use about two minutes after power is applied. A gyro brake applies friction drag in the roll axis to prevent nutation when electrical erect power is off.

A turn rate cutoff switch cuts off power to the torque motor in the roll axis when rate of turn exceeds 15 degrees per minute or bank angles exceeds 7 degrees. The turn rate cutoff switch is actuated by precession of a gyro. The gyro processes against spring pressure. Precession movement is damped by piston and cylinder dashpots. The operation of the turn cutoff system prevents the vertical gyro from erecting to a false bank angle during turns.

C. Autosyns.

Autosyn signal synchros are mounted in the pitch and roll gimbals of the vertical gyro. Excitation voltage for both autosyns is 115-volts ac. The stators of the autosyns are fixed to the gimbals and the rotors are attached to the vertical gyro. The outputs of the autosyns are therefore a function of the attitude of the airplane with reference to vertical position. The 3-wire outputs of the autosyn synchros are connected to the stators of synchro control transformers with locked rotors. The outputs of the control transformers provide the 2-wire low-impedance signal source of airplane pitch and roll attitude required by the autopilot system.

POWER JUNCTION BOX - MAINTENANCE PRACTICES

1. Removal/Installation Power Junction Box (see Figure 1)

   A. Equipment Required - None.

   B. Remove Power Junction Box.

      (1) Open AUTOPILOT circuit breaker on the main circuit breaker panel in the flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Gain access to the equipment rack in the forward left side of the electric compartment.

      (3) Release the safety lock on the dual-purpose handle and pull the handle down to disengage the electrical receptacles at the rear of the unit.

      (4) Pull the unit forward to disengage the handle from the hook on the mounting rack, and raise and lock the handle.

      (5) Lift the power junction box from the rack.

   C. Install Power Junction Box.

      (1) Lift the power junction box to the rack and engage the guide pins at the rear of the unit.

      (2) Unlock the dual-purpose handle and engage the lower end of the handle with the hook on the rack.

      (3) Raise the handle with a steady pressure to force the power junction box into position and lock the handle.

      (4) Close AUTOPILOT circuit breaker and remove warning sign.

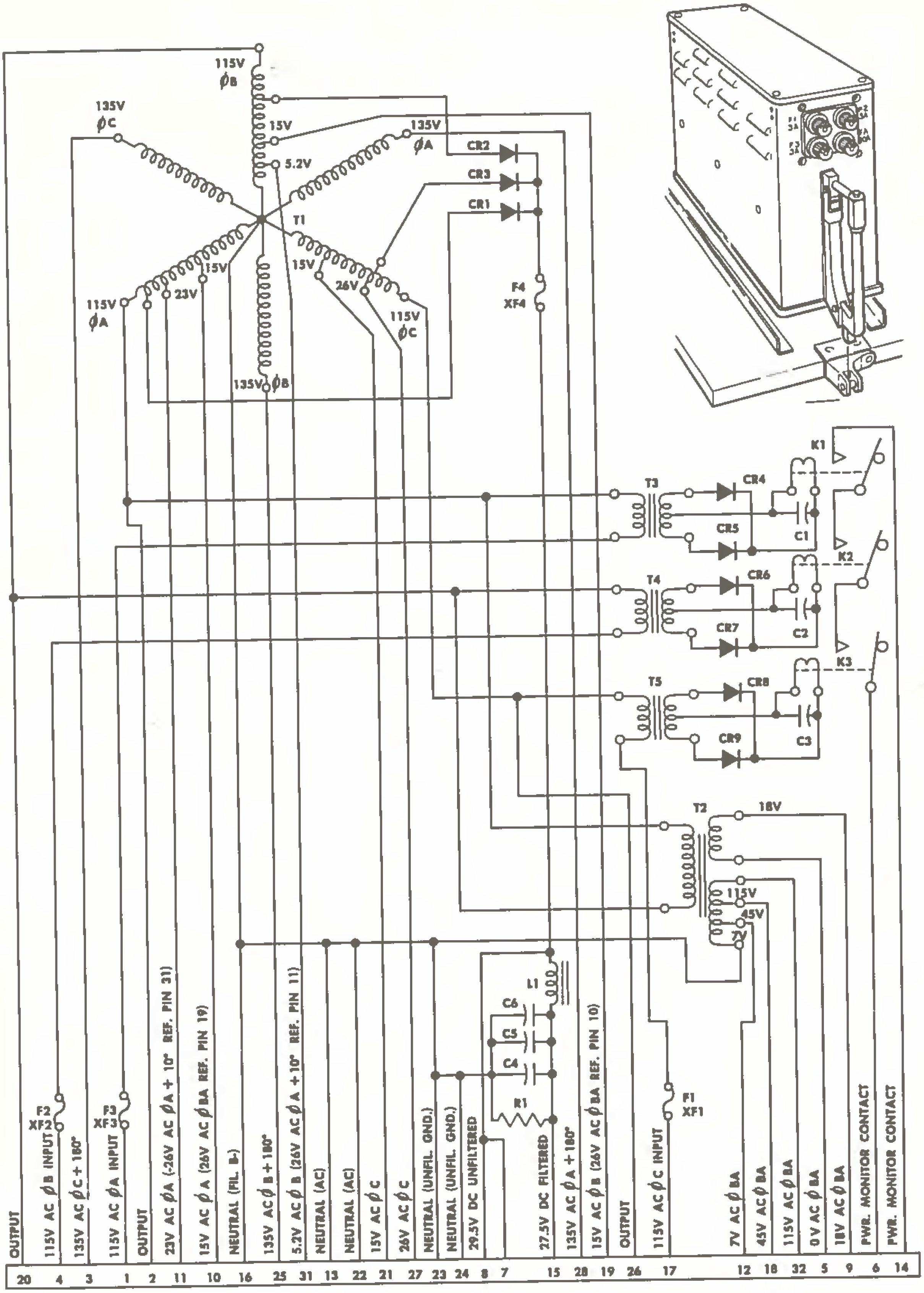
      (5) Test System operation, refer to 22-0, Adjustment/Test.

D. Interlock Relays.

The power junction box interlock relays monitor airplane electrical supply failure. The 27.5-volt dc supply current to servo clutches is connected through contacts of the interlock relays. If airplane 3-phase electrical power is cut off, or if any phase loses power, the autopilot disengages.

E. Circuit Protection.

Three 3-ampere fuses on the front panel of the power junction box unit protect the ac input circuits to the autopilot system. A 10-ampere fuse on the front panel protects the 27.5-volt dc output power circuit to the servo electromagnetic clutches.



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Power Junction Box
Figure 1

POWER JUNCTION BOX - DESCRIPTION AND OPERATION

1. Description

A. Power Inputs.

The power junction box takes ac electrical power from the ac generating system of the airplane and supplies ac and dc outputs of the voltage, frequency, and phasing required for operation of the autopilot system. Figure 1 shows an illustration and schematic diagram of the power junction box.

Three-phase, 115/200-volt, ac power from the airplane electrical system is connected through a receptacle at the rear of the power junction box to Y-connected T-1 transformer with grounded neutral.

The front panel of the box is equipped with a dual-purpose handle that serves to carry the unit and lock it in place on the shock-mounted rack at the left, forward side of the electrical compartment. See Figure 2, Section 22-1-2, for correct use of the dual-purpose handle.

B. Power Outputs.

The power junction box transformer T-1 is tapped to provide ac output voltages of 135, 29.5, 26, 15, and 5.2 volts. The 26-volt ac output provides excitation for the Autosyn synchros in the autopilot system. The 29.5-volt outputs are rectified and filtered to provide 27.5-volts dc to energize the electromagnetic clutches of the surface servos. The remaining outputs are used in transistor and magnetic amplifiers.

The T-2 transformer in the power junction box provides outputs 115, 18, and 7 volts ac. These are phase-reference outputs that are used in the amplifier-computer unit, in the air data sensors, and in the surface servos. The outputs of transformers T-3, T-4 and T-5 are rectified by diodes and are used to energize the interlock relays of the autopilot system.

C. Cooling.

Ventilating air is pulled into the power junction box case through louvers in the sides of the case and flows out through ducts in the shockmounted rack.

AMPLIFIER-COMPUTER - MAINTENANCE PRACTICES

1. Removal/Installation Amplifier-Computer

   A. Equipment Required - None.

   B. Remove Amplifier-Computer.

      (1) Open AUTOPILOT circuit breaker on the main circuit breaker panel in the flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Gain access to the equipment rack in the forward left side of the electrical compartment.

      (3) Release the safety locks on the dual-purpose handles and pull both handles down at the same time to disengage the electrical receptacles at the back of the unit. See Figure 2, for correct use of the dual-purpose handles.

      (4) Slide the amplifier-computer out to free the handles from the hooks on the mounting rack, and close and lock both handles.

      WARNING: MAKE SURE THE HANDLES ARE SECURELY LOCKED BEFORE LIFTING THE AMPLIFIER-COMPUTER WITH THE HANDLES. INJURY OR DAMAGE TO THE UNIT MAY RESULT IF THE HANDLES ARE NOT LOCKED.

      (5) Slide the amplifier-computer out and lift it from the rack.

   C. Install Amplifier-Computer.

      (1) Lift the amplifier-computer to the rack.

      (2) Unlock and lower the dual-purpose handles and push the amplifier-computer into position so that the guide pins engage at the rear of the unit and the lower ends of the handles engage with the hooks on the rack.

      (3) Lift both handles at the same time. Force the amplifier back with a steady pressure and lock the handles.

      (4) Close AUTOPILOT circuit breaker and remove warning sign.

      (5) Test System operation, refer to 22-0, Adjustment/Test.

Plug	Relay Type	Function
XK27	1282595-1	Rudder Engage, Thermal No. 3
XK28	1273165-8	G.S. Limit Thermal No. 1 (60 sec)
XK29	1273165-10	Sta. Mon. Thermal No. 2 (140 sec)
XK30	1282595-1	Rudder Engage Thermal No. 3 (0.5 sec)
XK31	1253328-1	Engage Interlock

Plug	Relay Type	Function
XK4	1267753-1	Detent Manual
XK5	1267753-1	Yaw Damper Tester
XK6	1267753-1	Glide Slope Arm
XK7	1267753-1	Flap Position
XK8	(Not used)	---
XK9	1267753-1	Warning Light
XK10	1267753-1	Loc. No. 1
XK11	1267753-1	Loc. No. 2
XK12	1267753-1	A/P Engage
XK13	1267753-1	Altitude Hold
XK14	1267753-1	G.S. No. 1
XK15	1267753-1	Pre-Set Heading (PSH)
XK16	(Not used)	---
XK17	1267753-1	Rudder Engage
XK18	1267753-1	LOC-VOR No. 1
XK19	1267753-1	LOC-VOR No. 2
XK20	1267753-1	Station Monitor
XK21	1267753-1	Manual
XK22	1267753-1	G.S. No. 2
XK23	1267753-1	Signal Switch
XK24	(Not used)	---
XK25	(Not used)	---
XK26	(Not used)	---

Plug	Card Type	Description	Function
J33	(Not used)	---	---
J34	(Not used)	---	---
J35	SA-111-A1	Low Pass Filter Amplifier	Ail. Data Smoother
J36	---	Flasher (1282945-1)	Warning Light
J37	(Not used)	---	---
J38	GL-1-B2	EM Computer	Ail. Integrator
J39	(Wired for GL-1-B2, but no unit plugged in)		Low-Pass Filter
J40	GL-1-B2	EM Computer	Elevator Integrator
J41	(Wired for an EM Computer Card, but no unit plugged in)		Compass Synchronizer
J42	(Not used)	---	---
J43	(Not used)	---	---
J44	SA-111-A1	Low-Pass Filter Amplifier	Ail. Synchronizer
J45	SA-78-B1	Filter, Band Pass	Elev. Band Pass Filter

B. Relays.

The following relays are required in the amplifier-computer:

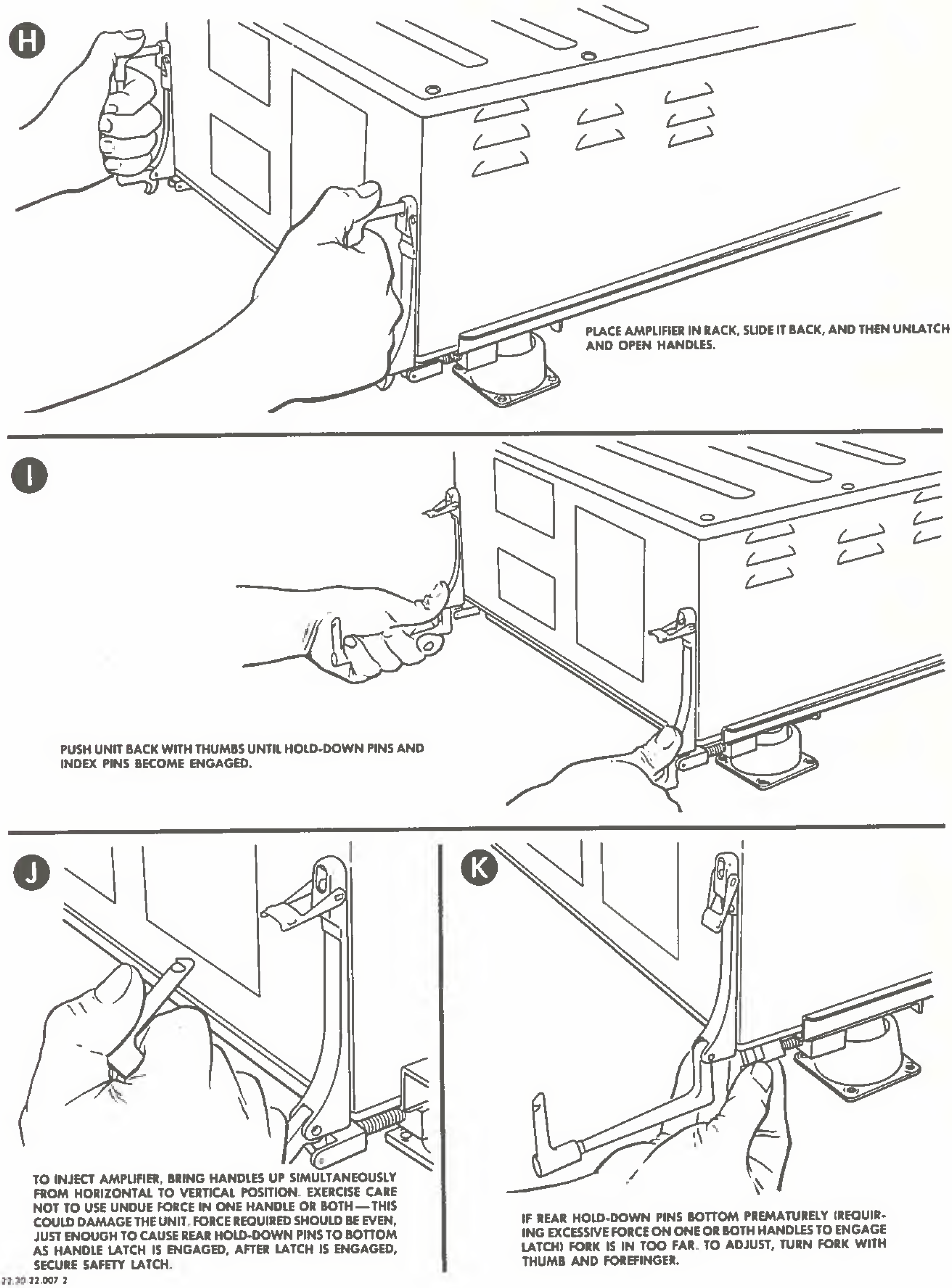
Plug	Relay Type	Function
XK1	1267753-1	Warning Light Power Relay
XK2	1283734-1	DC Power Interlock
XK3	1267753-1	LOC-VOR Amp.

Plug	Card Type	Description	Function
J15	SA-110-A1	Amplifier, Isolation	Pre-Set Heading and Versine
J16	SA-33-A1	Amplifier, Demodulator	Aileron Servo Amp.
J17	SA-33-A1	Amplifier, Demodulator	Rudder Servo Amp.
J18	SA-33-A1	Amplifier, Demodulator	Elevator Servo Amp.
J19	SA-126-A1	Amplifier Modulator Limiter	G.S. Modulator Limiter
J20	SA-126-A1	Amplifier Modulator Limiter	LOC-VOR Mod. Limiter
J21	SA-79-A1	Amplifier Modulator	Station Monitor
J22	SA-71-B1	Limiter, Electronic Control	Bank Angle Limiter
J23	(Wired for SA-99-☐ , but no unit plugged in)		Torque Modulation
J24	(Not used)	---	---
J25	SA-40-B1	Saturable Reactor	Ail. Mag. Amp.
J26	SA-40-B1	Saturable Reactor	Rudder Mag. Amp.
J27	SA-40-B1	Saturable Reactor	Elev. Mag. Amp.
J28	(Not used)	---	---
J29	SA-32-A1	Amplifier, Electronic Control	Ail. Integrator
J30	(Wired for SA-32-A1, but no unit plugged in)		Low-Pass Filter
J31	(Not used)	---	---
J32	(Wired for SA-32-A1, but no unit plugged in)		Compass Synchronizer

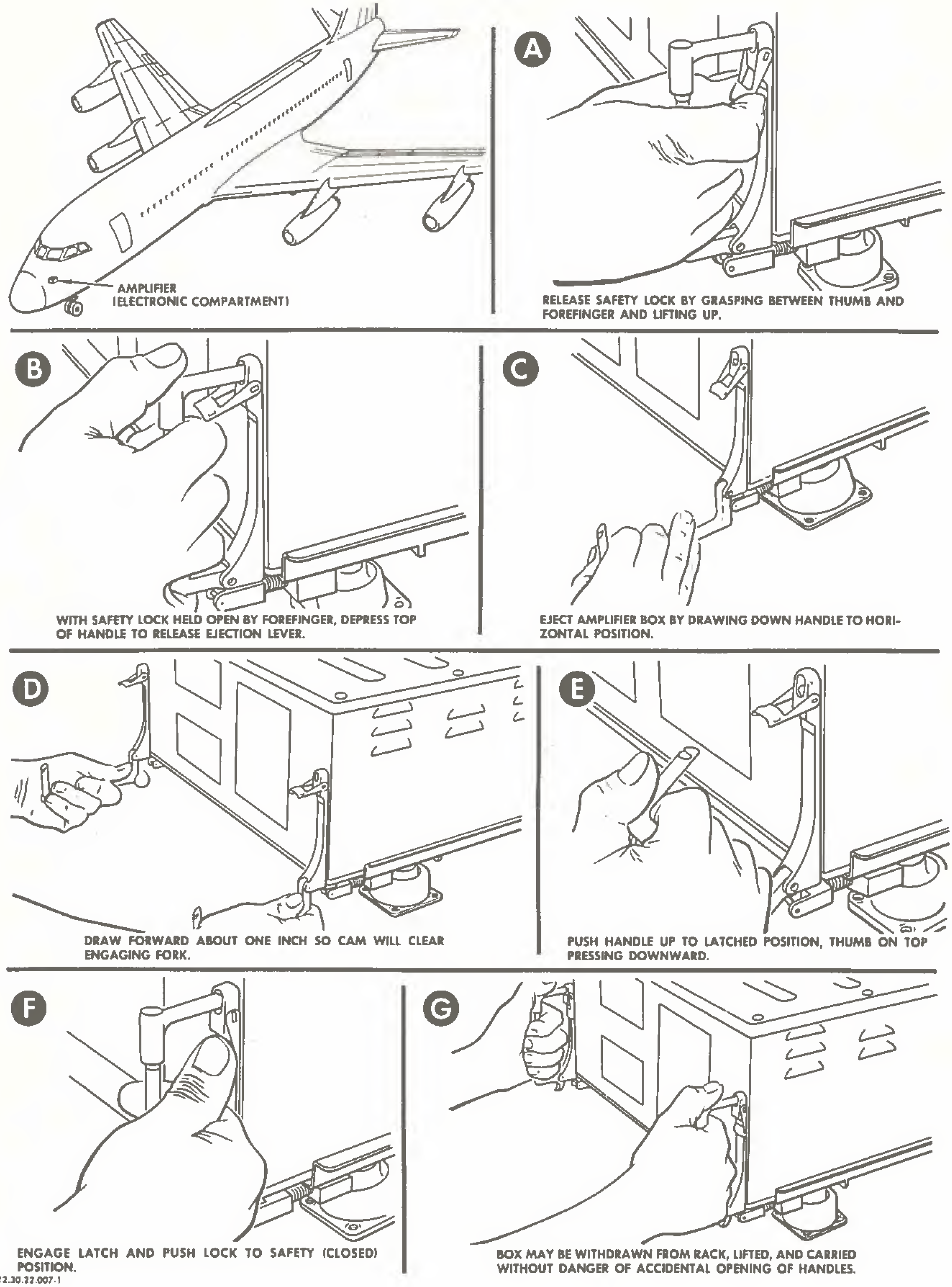
A. Amplifier Cards.

The following amplifier cards are required in the amplifier-computer:

Plug	Card Type	Description	Function
J1	SA-32-A1	Amplifier, Electronic Control	Air Data Sensor, Alt. Amp.
J2	SA-32-A1	Amplifier, Electronic Control	Air Data Sensor, (Ind.) Amp.
J3	SA-76-C1	Amplifier Demodulator	Auto Trim Amp./ Monitor
J4	SA-77-A1	Limiter, Time Delay	Ail. Command Modifier
J-5	(Wired for SA-101- but no unit plugged in)		Torque Modulation
J-6	(Not used)	- - -	- - -
J-7	SA-104-A1	Amplifier, Electronic Control	Ail. Pre-Amp.
J-8	SA-78-B1	Filter, Band Pass	Rudder Band Pass Filter
J-9	SA-104-A1	Amplifier, Electronic Control	Elevator Pre-Amp.
J10	SA-127-A1	Amplifier, Relay	G.S. Auto Engage/ Yaw Damper Comparison
J11	(Wired for SA-104-A1 but no unit plugged in)		Rudder Pre-Amp.
J12	SA-127-A1	Amplifier, Relay	Signal Switch
J13	SA-71-B1	Limiter, Electronic Control	Pitch Angle Limiter
J14	(Wired for SA-101 but no unit plugged in)		Torque Modulation



Use of Dual-Purpose Handles
Figure 2 (Sheet 2 of 2)



Use of Dual-Purpose Handles
Figure 2 (Sheet 1 of 2)

3. Operation

A plug-in adapter, SD-1-A1, is used with the basic amplifier-computer to adapt it for use in the PB-20G autopilot system. The adapter plugs into the forward part of the amplifier-computer chassis. The adapter modifies the circuitry of the amplifier-computer and adapts it to the requirements of the autopilot system. The adapter is physically identical to adapter SD-2-A1 used in other installations, but it is electrically distinct. The adapter contains interlocks that prevent engagement of the autopilot if an incorrect adapter is inserted.

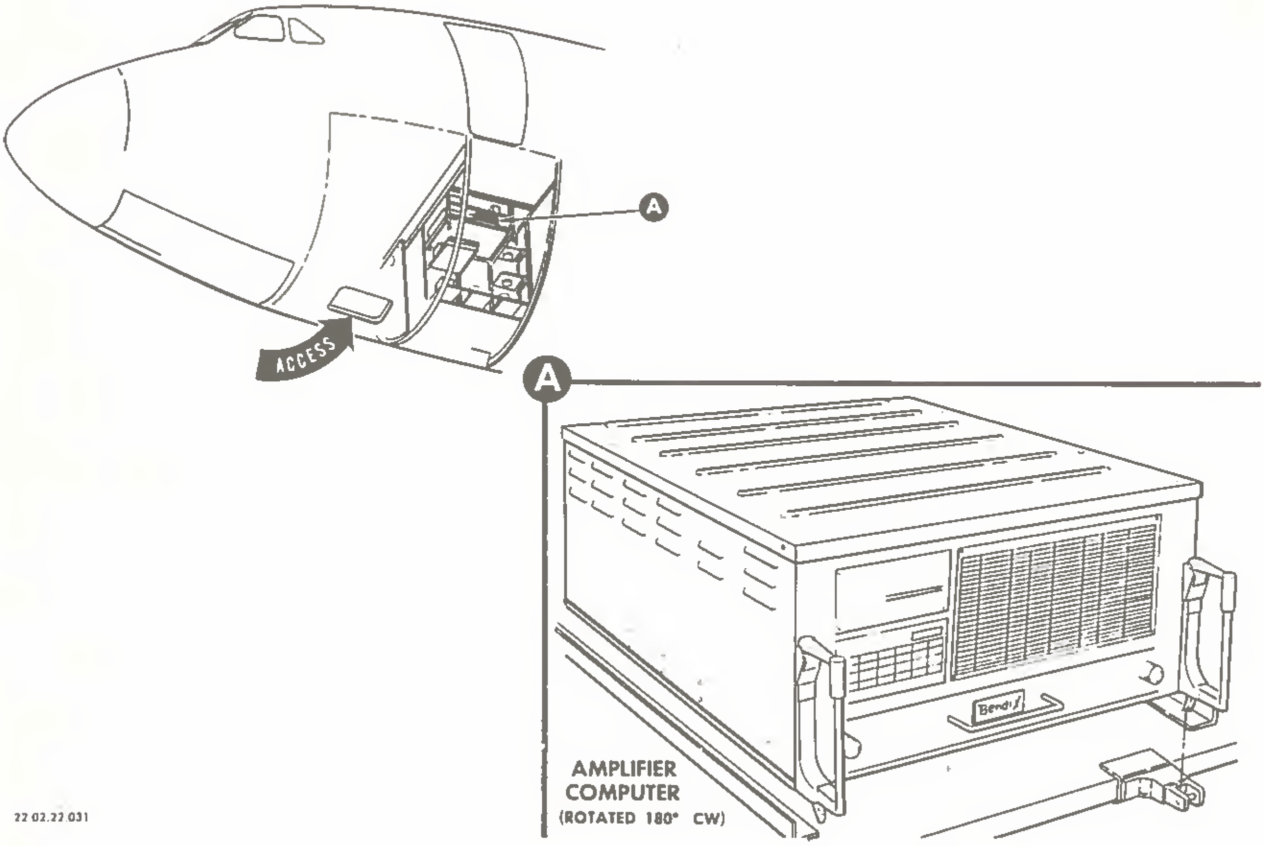
4. Handling and Instruction

The amplifier-computer unit has removable top and bottom covers that are held by Camloc screw fasteners. Springs on the top cover hold plug-in units firmly in their sockets when the cover is locked down. The front panel is equipped with two dual-purpose handles that serve to carry the unit and secure it in place on the mounting base. The handles are hinged at the bottom and held at the top by safety locks. When the unit is slid onto the mounting base with the handles open, cams on the lower ends of the handles engage hooks on the mounting base. Simultaneously raising and locking both handles forces the unit onto the base and holds it with a force of about 170 pounds. Both handles should be raised and locked at the same time to prevent damage to the unit, or to the electrical receptacles at the rear of the unit. Both handles should be unlocked and opened simultaneously to remove the amplifier-computer unit. The cams on the handles eject the unit from the mounting base and disconnect the electrical receptacles. Figure 2 shows how to use the handles on the amplifier-computer unit.

5. Plug-in Components

The plug-in card amplifiers, the electromechanical computer cards, and the relays have the type numbers on the upper side where they are visible with the cover of the amplifier-computer off. The J-numbers that designate the sockets into which the cards plug and the XK-numbers into which relays plug are located adjacent to the sockets.

The numbering system starts at the rear of the amplifier-computer. Since some sockets are invariably disoccupied, the numbers in the unused spaces help locate amplifier cards and relays for tests and replacement.



Amplifier-Computer
Figure 1

AMPLIFIER COMPUTER - DESCRIPTION AND OPERATION

1. Description

The amplifier-computer unit connects into aircraft electrical circuits through three receptacles on the rear of the unit. The unit is installed on a shockmounted rack at the forward left side of the electrical compartment. The chassis provides wired sockets for plug-in relays and plug-in card amplifiers. The amplifier cards and the sockets into which they can be plugged are identified by J numbers; the relays and relay sockets are identified by XK numbers. These letter and number designations also identify the signal chains in the unit and in the wiring diagrams of the unit. A plate attached to the front panel of the unit lists the type or part numbers of all plug-in components. Resistor and transformer terminal boards are attached by screws to the inner sides of the unit. These terminal boards can be released and turned for repairs and tests. Figure 1 is an illustration of the amplifier-computer.

The plug-in card amplifiers are transistorized and magnetic amplifiers. The modular design simplifies testing of amplifiers and systems. Card amplifiers can be plugged into a known good amplifier-computer to test the card amplifier. Known good card amplifiers can be plugged into faulty systems to test operation. The indexing of card amplifiers and sockets prevents possible damage caused by inserting incorrect amplifier cards.

The computer cards, of the amplifier-computer unit, are electromechanical and consist of a motor, a rate generator, an Autosyn synchro control transformer and clutch assembly, and a reduction gear assembly. One motor phase, the fixed phase, is given constant 400 cps excitation. The second phase, the variable phase, is supplied by the amplifier. The rate generator has a single-phase winding. The rotor of the rate generator is on an extension of the motor shaft. Rotation of the rotor develops a velocity or rate signal in the stator windings. The motor turns the shaft of the control transformer synchro through the gear train and clutch. The synchro shaft usually turns at a low rate, since the gear reduction ratio is large. The gear train engages to the shaft of the control transformer through the magnetic clutch. A centering lever mechanism for zero reset of the control transformer is restrained by a spring. Displacement stops are provided on both sides of center position. The clutch solenoid operates from 28 volts dc.

2. Cooling

Air is drawn into the amplifier-computer unit through perforations in the sides of the case and out through perforations in the bottom and through ducts in the shockmounted rack.

AUTOPILOT CONTROL PANEL - MAINTENANCE PRACTICES

1. Removal/Installation Autopilot Control Panel (see Figure 1)

   A. Equipment Required - None.

   B. Remove Autopilot Control Panel.

      (1) Open AUTOPILOT circuit breaker on the main circuit breaker panel in flight compartment. Hang a warning sign on opened circuit breaker.

      (2) Remove upper and lower cover plates, adjacent to the autopilot control panel, from both sides of the pedestal.

      (3) Disconnect and cap three electrical connectors on the canned units of the control panel.

      (4) Release four Camloc fasteners at the ends of the control panel.

      (5) Lift the control panel from the pedestal.

   C. Install Autopilot Control Panel.

      (1) Position the control panel in the pedestal and secure the four Camloc fasteners at the ends of the panel.

      (2) Connect three electrical connectors to the canned units of the control panel.

      WARNING: MAKE SURE THAT THE ELECTRICAL CONNECTOR CABLES ARE NOT ENTANGLED WITH THE CONTROL CABLES BENEATH THE PEDESTAL.

      (3) Replace the side cover plates of the pedestal.

      (4) Close AUTOPILOT circuit breaker and remove warning sign.

      (5) Test system operation, refer to 22-0, Adjustment/Test.

TEMPORARY REVISION NO. 22-4.

Insert facing 22-1-1, Page 201 dated Apr. 28/60.

Page 201, add new step (3) in paragraph B and renumber remaining steps as shown:

(3) Remove VHF/VOR control panel. Refer to Chapter 23, Section 23-2-1.

(4) Release four camloc fasteners at the ends of the control panel.

(5) Disconnect and cap three electrical connectors on the canned units of the control panel.

(6) Lift the control panel from the pedestal.

Page 201, add new step (3) in paragraph C and renumber remaining steps as shown:

(3) Install VHF/VOR control panel. Refer to Chapter 23, Section 23-2-1.

(4) Replace the side cover plates of the pedestal.

(5) Close AUTOPILOT circuit breaker and remove warning sign.

(6) Test system operation, refer to 22-0, Adjustment/Test.

center null position. As long as the two centering arms are held apart, the pitch attitude adjustment of the pitch potentiometers is retained. When the autopilot is disengaged, however, the centering levers drive the pitch potentiometers and the turn control potentiometer to zero-signal positions.

D. Mode Selector Switch.

The mode selector switch is a 5-position rotary switch. Switch positions are engraved HDG, MAN, LOC-VOR, GS AUTO, and GS MAN. The spring-loaded switch returns automatically to MAN position if the holding solenoid de-energizes. The solenoid releases the switch when the autopilot disengage switch is depressed or when electrical power is disconnected.

NOTE: Autopilot should be engaged and turn control should be in center detent position before actuating the selector switch to any position other than MAN.

B. Altitude Switch.

The two-position altitude switch is spring-loaded to OFF position and is solenoid-held in ALT position. The solenoid energizes when the autopilot engages and the altitude switch is moved to the ALT position. The switch automatically returns to OFF position when the autopilot disengages or electrical power is disconnected.

Actuating the altitude switch to ALT position, while the autopilot is engaged, causes the airplane to return to and maintain the altitude it had when the switch was actuated. In a climb or a dive the airplane can be leveled off by actuating the switch to ALT position.

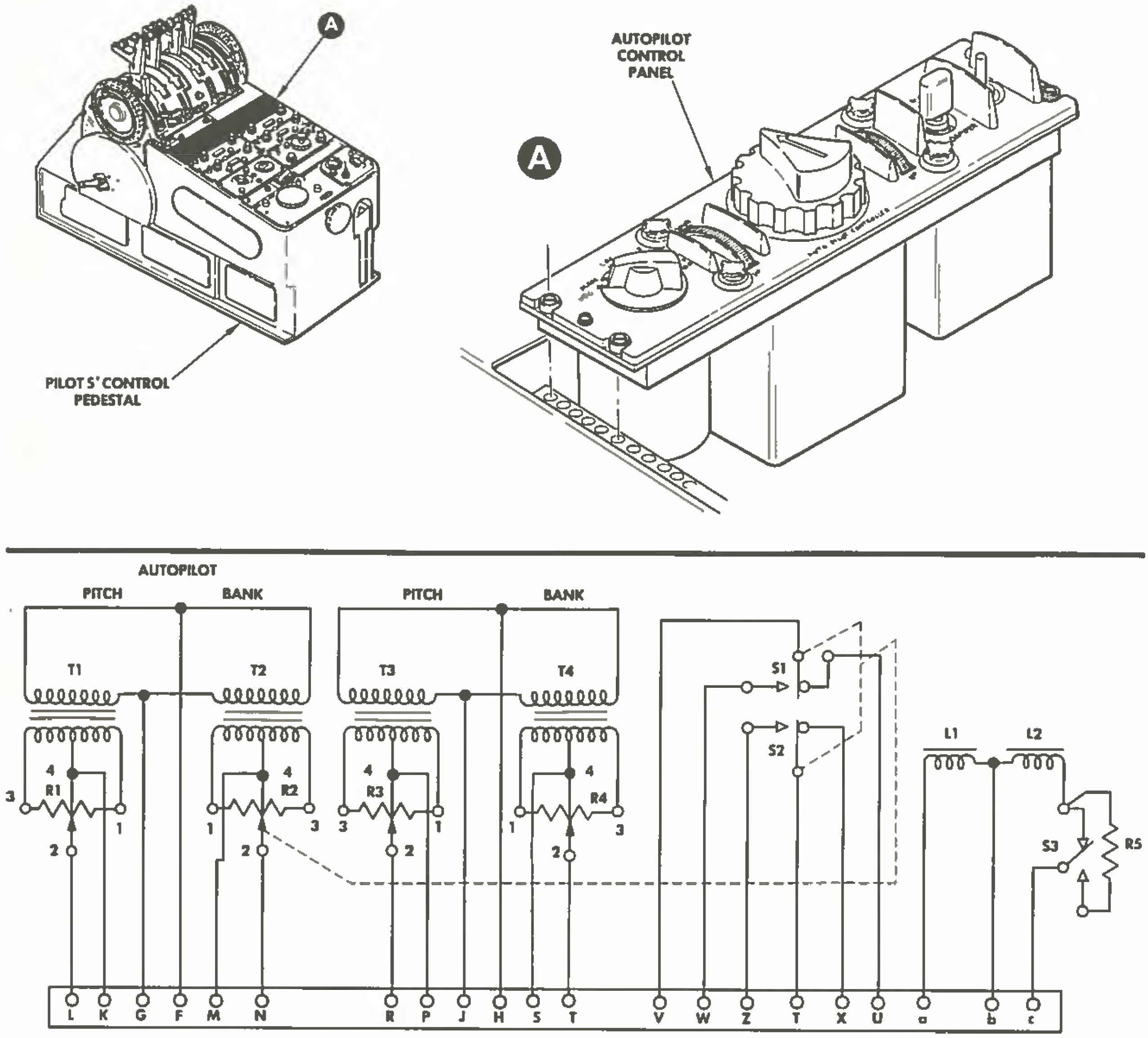
C. Turn Knob and Pitch Wheels.

The turn control knob is linked to a bank signal potentiometer in the center can of the control panel. The potentiometer is connected across the output windings of a signal transformer. Rotating the control knob from center detent position turns the airplane to right or left in a coordinated banked turn.

Two microswitches are linked to a detent position of the turn control knob. Contacts of both microswitches are closed when the control knob is in detent position, and contacts of both microswitches are open when the turn control is out of detent position. Microswitch No. 2 prevents engagement of the autopilot when the turn control is out of detent position; microswitch No. 1 cuts out the compass heading control when the mode selector switch is in HDG or LOC-VOR position.

The pitch control wheels are linked to potentiometers in the center can of the control panel by a solenoid-operated clutch. The pitch control solenoid is energized except when the altitude control switch is actuated to ALT position or when GS AUTO or GS MAN mode is selected. The pitch control potentiometers are connected across the output windings of the pitch signal transformers. The center positions of the arms of the potentiometers correspond to neutral position of elevator trim. Moving the pitch wheels toward UP or DOWN positions provides nose up or nose down trim signals for the trim servo. Autopilot can be engaged with the pitch wheels in any position; but the airplane will maintain the attitude called for by the position of the pitch wheels. The pitch wheels are unclutched from the control potentiometers when the altitude switch is engaged or when GS AUTO mode is selected. Automatic trim is thus prevented from opposing altitude or glide slope commands; and the pitch wheels can be turned without moving either potentiometer arm.

A second solenoid in the center can assembly of the control panel, which energizes when the autopilot engages, holds apart two centering levers that act on the arm of the turn control potentiometer to drive it to



SCHEMATIC SYMBOL	FUNCTION	DESCRIPTION
T1, T2, T3, T4	CONTROL SIGNAL INPUT	TRANSFORMER
R1, R2, R3, R4	ATTITUDE CONTROL	POTENTIOMETER
R5	VOLTAGE DROP	RESISTOR
L1	PITCH CLUTCH SOLENOID	COIL
L2	PITCH POT. CENTERING SOLENOID	COIL
J1	ELECTRICAL CONNECTOR	RECEPTACLE
S1	COMPASS HEADING CUTOUT SWITCH	MICROSWITCH
S2	A/P DISENGAGED SWITCH	MICROSWITCH
S3	CURRENT CONTROL SWITCH	MICROSWITCH

22.02.22.030

Autopilot Control Panel
Figure 1

AUTOPILOT CONTROL PANEL - DESCRIPTION AND OPERATION

1. Description

The autopilot control panel consists of three canned units attached to a front plate. The cans are sealed by gaskets to prevent entry of moisture or dirt. An electrical connector is mounted on each can. The left can contains the solenoid-held, mode selector switch. The center can contains turn and pitch control potentiometers and two solenoids. The right can contains the solenoid-held, autopilot-damper switch and the two-position, solenoid-held, altitude control switch. Pitch wheels are mounted on the panel on each side of the center turn control knob. Guards between controls reduce interference with adjacent switch or control settings when operating the controls. Switch positions are engraved on a lucite plate mounted on the panel and are illuminated by four internally-mounted lamps. Lettering is red at night and white by daylight. Panel lighting conforms to MIL specifications. Four Camloc fasteners secure the control panel to the pedestal between the pilots. Electrical connections are made through three cable connectors in the pedestal. Figure 1 shows an illustration and schematic diagram of the control panel.

A. AUTOPILOT-OFF-DAMPER Switch.

The AUTOPILOT-OFF-DAMPER switch is spring-loaded to OFF position and solenoid-held to AUTOPILOT and DAMPER positions. The solenoid energizes when the autopilot engages. The switch automatically returns to OFF position when the autopilot disengages or when electrical power is disconnected.

The autopilot engages when the AUTOPILOT-OFF-DAMPER switch is actuated to AUTOPILOT position, if all interlock requirements are satisfied. The autopilot then controls flight according to the mode selected.

DAMPER position of the control panel switch augments airplane stability in yaw during manual control by placing the rudder under automatic control. Aileron and elevator are unaffected. Automatic rudder can be overpowered for turn maneuvering. To engage the damper, the autopilot must first be disengaged by actuating the disengage switch on one of the control columns or by actuating the AUTOPILOT-OFF-DAMPER switch to OFF position. Control panel switches then return automatically to their spring-loaded positions. Then damper control is initiated by actuating the autopilot-damper switch to DAMPER position.

Three autopilot system warning lights are located on the left center of the center instrument panel, above the autopilot three-axis trim indicator. These are the AUTOPILOT DISENGAGED, the ELEVATOR OUT OF TRIM, and the GLIDE SLOPE ARMED warning lights.

AUTOPILOT SYSTEM COMPONENTS - DESCRIPTION AND OPERATION

1. General

The following table lists the principal units that comprise the autopilot system.

Name	Quantity	Eclipse-Pioneer Type Number
Control Panel	1	16906-1-B
Amplifier-Computer	1	15470-1-A1
Power Junction Box	1	DR-51-A1
Vertical Gyro Transmitter	1	15837-1-C
Three-Axis Rate Control	1	15831-1-A
Air Data Sensor	1	4918-1-A
Autopilot Adapter	1	15236-1-A1
Three-Axis Trim Indicator	1	15101-1F-A1
Position Transmitters	2	4559-7-A6-1
Surface Servos	3	15653-1-A
Stabilizer Trim Servo	1	15673-1-A

The control panel is located on the control pedestal between the pilots. The amplifier-computer, the power junction box, the air data sensor, and the autopilot adapter are installed in the equipment rack in the forward left side of the electrical compartment. The vertical gyro transmitter and the three-axis rate control unit are located beneath the equipment rack. The three-axis trim indicator is located on the center, left side of the engine instrument panel. The position transmitters are installed at the center of the inboard spoilers to which they are mechanically linked. The rudder and elevator servos are installed in the tail section of the airplane, the aileron servo in the hydraulic compartment.

Two torque-limiting resistors, one in the aileron channel and one in the elevator channel, are installed at the back of the upper left section of the equipment rack. These resistors are made accessible by removing the power junction box and other units on the upper shelf. A third torque-limiting resistor, in the rudder channel, is installed on the center supporting structure of the upper shelf.

(4) Turn off VHF navigation systems.

(5) Turn off cooling fan.

(6) Turn off hydraulic pump.

(7) Make sure that vertical gyro and directional gyro are correctly re-installed.

(8) Remove control surface battens.

From	To	Resistance (Ohms)
P1-31	P1-32	3300
P1-34	P1-36	3300
P1-35	P1-38	0
P1-36	P1-37	0
P1-37	P1-38	10,000
P1-40	P1-41	0
P1-43	P1-44	0
P2-2	P2-3	0
P2-4	P2-5	0
P2-6	P2-8	27,000
P2-10	P2-12	0
P2-13	P2-14	0
P2-16	P2-18	0
P2-16	P2-17	200
P2-17	P2-19	0
P3-4	P3-11	0
P3-4	P3-10	6800
P3-5	P3-9	27,000
P3-5	P3-12	0
P3-10	P3-15	0
P3-12	P3-14	470
P3-13	P3-14	9100
P3-16	P3-19	6200
P3-17	P3-18	2700
P3-17	P3-20	0
P3-21	P3-22	0
P3-24	P3-25	242
P3-26	P3-27	390
P3-26	P3-29	0
P3-27	P3-28	10,000
P3-30	P3-32	3300
P3-31	P3-32	1600
P3-31	P3-33	0
P3-34	P3-38	0
P3-36	P3-37	3900
P3-37	P3-38	6800
P3-39	P3-40	1200
P3-39	P3-45	910
P3-40	P3-44	0
P3-46	P3-47	0
P3-48	P3-49	242

U. Cleanup After Tests

(1) Shut off external electrical power.

(2) Disconnect and remove pitot-static test stand line, install plug in autopilot static line T-fitting, and remove static port seals.

(3) Turn off and remove radio test sets.

(15) Actuate the cycling unit MAN ONLY selector switch of the G-250A test set to GS BOTH position. The control columns should move to neutral position, the glide slope deviation bar should return to center position on the course deviation indicator, and the GLIDE SLOPE ARMED light should extinguish, simulating capture of the glide slope path beam.

(16) Apply pressure to the right-hand pitot tube to simulate 1500 feet altitude.

(17) Actuate the MAN ONLY selector switch of the test set to GS 90 position and the autopilot mode selector switch to GS AUTO mode. The control columns should move aft.

(18) Decrease the pressure altitude quickly to zero. The control columns should move toward neutral then continue to move slowly aft.

(19) Return to MAN autopilot mode, GS 150 position of the test set, and simulate 1500 feet pressure altitude.

(20) Select GS AUTO mode. The control columns should move forward.

(21) Decrease the pressure altitude quickly to zero. The control columns should move toward neutral position then continue slowly forward.

(22) Disengage autopilot system.

T. Test SD-1-A1 Amplifier-Computer Adapter

(1) Measure point-to-point resistance of SD-1-A1 adapter with ohmmeter. Ohmic resistance should be as shown in the following table.

NOTE: Resistor R-38 (P3-24 to P3-25) and resistor P-39 (P3-48 to P3-49) have a tolerance of 10 percent. All other resistors in the adapter have a tolerance of 5 percent. Replace any resistor that does not measure within permissible tolerance.

From	To	Resistance (Ohms)
P1-1	P1-3	0
P1-1	P1-2	2400
P1-2	P1-4	2400
P1-5	P1-7	0
P1-5	P1-8	0
P1-9	P1-11	0
P1-10	P1-11	5100
P1-10	P1-12	0
P1-13	P1-15	0
P1-26	P1-28	0
P1-26	P1-27	0
P1-30	P1-33	0
P1-30	P1-32	2200

S. Test GS MAN and GS AUTO modes of autopilot operation.

(1) Actuate the CHANNEL selector switch of the localizer section of the G-250A test set to 109.3 mc, and the MAN ONLY selector switch of the cycling unit to LOC 90 position.

(2) Tune both VHF navigation receivers to 109.3 mc. The course deviation indicator should deflect to the left.

(3) Set the course cursor of the course deviation indicator to the magnetic heading of the airplane.

(4) Select No. 1 position of the DEVIATION VOR toggle switch on the pilot's instrument panel.

(5) Engage the autopilot and select GS MAN mode. The control wheels should move counterclockwise and the left rudder pedal should move forward.

(6) Actuate the autopilot mode selector switch to MAN position.

(7) Actuate the MAN ONLY selector switch of the cycling unit to LOC 150 position. The course deviation bar of the course deviation indicator should deflect to the right.

(8) Select GS MAN mode of autopilot operation. The control wheels should move clockwise and the right rudder pedal should move forward.

(9) Select MAN mode on the autopilot control panel.

(10) Actuate the glide slope CHANNEL selector switch of the G-250A test set to 332.0 mc, and select GS 90 position of the MAN ONLY selector switch. The glide slope deviation bar of the course deviation should deflect upward.

<u>NOTE:</u> The glide slope frequency of 332.0 mc is selected when 109.3 mc is selected on the VHF navigation receiver.

(11) Select GS AUTO mode of autopilot operation. The control columns should move aft.

(12) Select MAN mode of autopilot operation.

(13) Actuate the cycling unit MAN ONLY selector switch of the G-250A test set to GS 150 position.

(14) Select GS AUTO mode of autopilot operation. The glide slope deviation bar of the course deviation indicator would move downward, the GLIDE SLOPE ARMED light should illuminate, and the control columns should move forward.

(3) Engage the autopilot in MAN mode.

(4) Adjust the course cursor of the pilot's course deviation indicator (CDI) to the magnetic heading of the airplane.

(5) Actuate the MAN ONLY selector switch of the G-250A test set to LOC BOTH position.

(6) Select LOC-VOR mode on the autopilot control panel.

(a) The course deviation bar of the CDI shall center and coincide with the course cursor.

(b) The control wheels shall not move from neutral position.

(7) Actuate the MAN ONLY selector switch of the cycling unit to LOC 90 position.

(a) The course deviation bar shall move to the left of the course cursor.

(b) The control wheels shall rotate slowly counterclockwise.

(8) Actuate the MAN ONLY selector switch of the cycling unit to LOC 150 position.

(a) The course deviation bar shall take a position to the right of the course cursor.

(b) The control wheels shall rotate clockwise.

(9) Actuate the autopilot mode selector switch to MAN position.

(10) Actuate the MAN ONLY selector switch of the cycling unit to LOC BOTH position.

(11) Adjust the CDI course cursor to magnetic heading of the airplane plus 10 degrees.

(12) Select LOC-VOR mode. The control wheels shall rotate counterclockwise.

(13) Select MAN mode, set the control wheels at neutral position, and adjust the course cursor to magnetic heading of the airplane minus 10 degrees.

(14) Select LOC-VOR mode. The control wheels shall rotate clockwise.

(15) Actuate the mode selector switch to MAN position.

(6) Select No. 2 compass system and repeat steps (2) through (5).

NOTE: As an alternate procedure, turn the directional gyro several degrees to the right and then to the left of airplane magnetic heading. Control wheels shall turn clockwise after the gyro is turned right and counterclockwise after the gyro is turned left.

Q. Test Heading Mode Operation.

(1) Select No. 1 remote compass system.

(2) Engage the autopilot in MAN mode with controls in neutral position.

(3) Turn the HDG knob on the course deviation indicator to set the heading cursor to the airplane heading.

(4) Apply pressure to the right-hand pitot tube to simulate 300 knots airspeed.

(5) Select HDG mode on the autopilot control panel.

(6) Move the heading cursor two degrees right of airplane heading. The control wheels shall move quickly clockwise and then continue to rotate clockwise slowly.

(7) Reduce the simulated airspeed suddenly to zero. Control wheel shall momentarily turn counterclockwise, then continue slowly clockwise.

(8) Move the heading cursor two degrees left of the airplane heading. Control wheels shall move quickly counterclockwise and then continue to rotate slowly counterclockwise.

(9) Actuate the mode selector switch to MAN position.

(10) Set the heading cursor 15 degrees right of the airplane heading.

(11) Actuate the mode switch to HDG position. Control wheels shall rotate clockwise.

(12) Move the heading cursor slowly toward increased heading. Control wheels shall rotate clockwise until a point is reached where increase in heading causes no further control wheel rotation.

(13) Select No. 2 compass system and perform steps (2) through (12).

R. Test LOC-VOR Mode of Autopilot Operation.

(1) Set the localizer CHANNEL selector switch of the G-250A test set to 109.3 mc.

(2) Tune the VHF No. 1 and No. 2 navigation receivers to the same frequency.

(13) Engage the autopilot, leaving the mode selector switch in MAN position. The control wheels shall move slowly clockwise for about four seconds then stop.

(14) Disengage the autopilot and reinstall the vertical gyro.

O. Test Air Data Sensor Altitude Control Operation.

(1) Connect the pitot-static tester to the right-hand pitot tube and to the right-hand autopilot static pressure port.

(2) Engage the autopilot in MAN mode.

(3) Apply pressure to simulate 1000 feet altitude and 200 knots airspeed.

(4) Actuate the altitude control switch on the control panel to ALT position.

(5) Rotate the pitch wheel on the control panel. The control columns shall not move.

(6) Increase the pressure altitude to 1050 feet. The control columns shall move forward, then slowly creep forward.

(7) Decrease the pressure altitude to 950 feet. The control columns shall move aft, then continue to creep aft.

(8) Decrease the simulated airspeed to zero knots. The control columns shall momentarily move aft more rapidly, then continue to creep aft.

P. Test Clutches Compass Heading Operation.

(1) Select No. 1 remote compass system by toggle switch on the pilot's instrument panel.

(2) Slave the No. 1 compass to the magnetic heading of the airplane by actuating the DG-SLA-SYN switch, on the compass control panel, to SYN position.

(3) Engage the autopilot in MAN mode.

(4) Actuate the SET control of the compass control panel toward INC HDG to set the RMI compass card 90 degrees higher than the airplane heading, then release. The compass wheels shall move slowly in a clockwise direction as the RMI compass card slowly returns to airplane heading.

(5) Set the compass card to 90 degrees to the left of airplane heading. Control wheels shall move slowly counterclockwise as the RMI compass card slaves to airplane heading.

(9) Hold the three-axis gyro level in pitch and tip the right side down. Control wheels shall rotate counterclockwise and then return to neutral position.

(10) Tip the left side of the three-axis gyro down. Control wheels shall rotate clockwise and then return to neutral position.

(11) Reinstall the three-axis gyro.

N. Test Vertical Gyro Operation.

(1) Remove three bolts securing the No. 2 vertical gyro to the mounting base in the electrical compartment.

(2) Engage the autopilot in AUTOPILOT and MAN modes.

(3) Hold the vertical gyro level in roll while tipping the forward side up 5 to 15 degrees. The control columns shall move forward.

(4) Tip the forward side of the vertical gyro downward. The control column shall move aft.

(5) Connect the pitot-static tester to the right-hand pitot tube and apply pressure to simulate 300 knots airspeed.

(6) Hold the vertical gyro level in pitch and tip the left side 20 to 30 degrees down to simulate left wing down.

(a) The control wheels shall rotate clockwise.

(b) The right rudder pedal shall move forward.

(c) The control columns shall move aft.

(7) Reduce simulated airspeed to zero knots. The control columns shall move further aft.

(8) Level the vertical gyro. Controls shall return to neutral position.

(9) Tip the vertical gyro right for a right wing down signal.

(a) The control wheels shall rotate counterclockwise.

(b) The left rudder pedal shall move forward.

(10) Level the gyro to return the controls to neutral.

(11) Disengage the autopilot.

(12) Hold the vertical gyro level in pitch and tip it about 10 degrees down to the right.

(11) Return speed brake handle to stowed position. Control wheels should not move. All spoilers should return to streamline position.

(12) Disengage autopilot system.

L. Test Overpower Forces.

(1) Engage autopilot in AUTOPILOT mode.

(2) Center rudder pedals, control wheels, and control columns.

(3) Attach the spring scale to a rudder pedal and pull aft. Read the scale at the moment the rudder pedal begins to move. Force required to move the pedal should not exceed 106.5 pounds.

(4) Attach spring scale to tip of grip of either control wheel and pull to overpower autopilot. Read scale at moment control wheels begin to move. Overpower force should not exceed 29.5 pounds.

(5) Attach spring scale to top center of either control wheel and pull aft on the control column to overpower autopilot. Read scale at moment control column begins to move. Overpower force should not exceed 34.0 pounds.

(6) Disengage the autopilot system.

M. Test Three-Axis Rate Gyro Operation.

(1) Remove four bolts securing the three-axis rate gyro to the mounting base.

(2) Actuate autopilot engage switch to AUTOPILOT position.

(3) Slowly rotate the three-axis gyro clockwise. The left rudder pedal shall move forward and then return to neutral.

(4) Stop the movement of the three-axis rate gyro. The right rudder pedal shall move forward and then return to neutral.

(5) Rotate the three-axis rate gyro counterclockwise and note opposite response of the rudder pedals from that obtained in steps (3) and (4).

(6) Slowly tip the forward side of the three-axis rate gyro upward. The control columns shall move forward and then return to neutral.

(7) Stop the tipping motion of the three-axis rate gyro. The control columns shall move aft and then return to neutral.

(8) Tip the forward side of the three-axis rate downward and note opposite response of the control columns from that obtained in steps (6) and (7).

(24) Disengage the autopilot.

(25) Increase pitot pressure to 33.03 inches of mercury to simulate about 250 knots airspeed.

(26) Begin rotating the normal trim wheels toward nose-up position and start the stop watch at the same time. The stabilizer trim indicator should move from the 2° position to the 10° position in 36 ($\pm$4) seconds.

(27) Engage the autopilot system in AUTOPILOT mode.

(28) Begin rotating the normal trim wheels toward nose-down position, at the same time starting the stop watch. The trim indicator should require 81 ($\pm$8) seconds to move from 10° nose-up to 2° nose-up position.

(29) Disengage the autopilot system.

(30) Release pitot pressure in the pitot system.

K. Test Spoiler Transmitters.

(1) Actuate the HYD PUMP switch on the flight engineer's panel to OFF position.

(2) Actuate the STAB TRIM HYD SHUTOFF switch on the pedestal to CLOSE position.

(3) Center control wheels, control columns, and rudder pedals.

(4) Engage the autopilot in AUTOPILOT mode.

(5) Manually raise right-hand inboard spoiler. Control wheels should rotate to the left.

(6) Lower spoiler to streamline position. Control wheels should return to center position.

(7) Manually raise left-hand inboard spoiler. Control wheels should rotate to the right.

(8) Lower spoiler to streamline position. Control wheels should return to center position.

(9) Actuate HYD PUMP switch to ON position and STAB TRIM HYD SHUTOFF switch to OPEN position.

(10) Actuate speed brake handle to 30° position. Control wheels should not move. Right-hand and left-hand inboard and outboard spoilers should rise to about half of full travel.

stabilizer should move upward. The out-of-trim warning light should light 4.25 (±.25) seconds after the trim wheels begin to rotate.

(12) Return control columns to neutral position. The EL trim bar should center; the stabilizer trim wheels should stop moving; and the out-of-trim warning light should extinguish.

(13) Push control columns slowly forward and hold them forward until stabilizer trim wheels begin to turn. Start the stop watch, and stop the watch when the red out-of-trim warning light lights. The EL trim bar should move above center. The stabilizer trim wheels should rotate aft. The stabilizer leading edge should move downward. The red out-of-trim warning should light 4.25 (±.25) seconds after the stabilizer trim wheels start to turn.

(14) Return control columns to neutral position. El trim bar should center; out-of-trim warning light should extinguish; and stabilizer trim wheels should stop turning.

<u>WARNING:</u> WARN EVERYBODY TO LEAVE THE WING FLAP AREA BEFORE LOWERING FLAPS FOR THE FOLLOWING TESTS.

(15) Unlock the flap control lever and lower the wing flaps to "20° DETENT" position.

(16) Repeat time delay tests of steps 11 and 13. Result should be the same except that out-of-trim warning light delay should be 2.25 (±.25) seconds.

(17) Raise the wing flaps and lock the flap control lever.

(18) Disengage the autopilot system.

(19) Pressurize copilot's pitot pressure system slowly to 32.73 inches of mercury to simulate about 238 knots airspeed.

(20) Actuate the STAB TRIM CONT switch on the control wheel and hold the switch until the stabilizer position indicator on the instrument panel reaches 2° nose-up position.

(21) Now actuate the trim switch for nose-up trim and simultaneously start the stop watch. Hold the trim switch until the trim indicator reaches 10° nose-up position, then release the trim switch and stop the stop watch. Stabilizer should move from 2° position to 10° position in 21 (±1) seconds.

(22) Engage the autopilot system in AUTOPILOT mode.

(23) Rotate the normal trim wheels on the pedestal toward nose-down position, starting the stop watch simultaneously with starting rotation of the trim wheels. The time required for the trim indicator to move from the 10° position to the 2° position should be 81 (±8) seconds.

(10) Actuate the flap control lever to FULL UP position.

(11) Repeat steps 7 through 10 for left rotation of aileron control wheel.

(12) Disengage autopilot system.

J. Test Stabilizer Trim System.

CAUTION: DURING THE TESTS THAT FOLLOW WATCH THE STABILIZER POSITION INDICATOR ON THE INSTRUMENT PANEL. DO NOT ALLOW THE STABILIZER TO REACH EITHER LIMIT STOP. DISENGAGE THE AUTOPILOT SYSTEM BEFORE THE HORIZONTAL STABILIZER REACHES FULL UP OR FULL DOWN POSITION.

(1) Actuate the thumb-operated stabilizer trim switches on the outboard grips of the pilot's and copilot's control wheels. Keep one of the switches actuated until the stabilizer position indicator shows 2 or 3-degrees nose-up attitude, then actuate the switch to drive the indicator to 2 or 3 degrees nose-down attitude.

(2) Engage the autopilot system in AUTOPILOT mode.

(3) Actuate stabilizer trim switch on control wheel. Horizontal stabilizer should not respond to control wheel trim switches.

(4) Disengage the autopilot by control wheel disengage switch.

(5) Center control columns, control wheels, and rudder pedals.

(6) Actuate control wheel stabilizer trim switch so that stabilizer position indicator shows 5 degrees nose up.

(7) Engage autopilot system in AUTOPILOT mode. Autopilot trim indicator should show trim in all three axes.

(8) Rotate pitch wheels forward for nose-down command. Control columns should move forward before stabilizer trim wheels on forward sides of pedestal begin to rotate.

(9) Rotate pitch wheels aft for nose-up command. Control columns should move aft before stabilizer trim wheels begin to rotate.

(10) Center control columns by pitch wheels.

(11) Move the control columns slowly aft with enough force to overpower the autopilot. Start the stop watch when the stabilizer trim wheels on the pedestal begin to rotate, and stop the watch when the red elevator out-of-trim warning light illuminates on the instrument panel. The EL bar of the trim indicator should move below center when the control columns move aft. The stabilizer trim wheels should rotate forward. The leading edge of the horizontal

(7) Allow control wheels and AIL bar to center, then rotate control wheels to left to overpower autopilot. AIL bar should tilt right from center.

(8) Allow control wheels and aileron trim bar to center.

(9) Push the control columns slowly forward. The EL trim bar should move above center position.

(10) Return the control columns to neutral position, then pull the columns aft. The EL trim bar should move below center position.

(11) Disengage the autopilot system.

I. Test Aileron Operation.

(1) Center rudder pedals, control wheels, and control columns.

(2) Engage autopilot in AUTOPILOT mode.

(3) Rotate TURN knob fully clockwise. Aileron control wheels should rotate clockwise. Right-hand aileron flight tab should move down and left-hand aileron flight tab should move up. Right-hand spoilers should move up. AIL trim bar should tilt right.

(4) Rotate TURN knob to center detent position. Control wheels should return to center position. Aileron flight tabs should return to neutral positions. Right-hand spoilers should return to streamline positions. Aileron trim bar should center.

(5) Rotate TURN knob fully counterclockwise. Control wheels should rotate counterclockwise. Right-hand aileron flight tab should move up and left-hand aileron tab should move down. Left-hand spoilers should move up. AIL trim bar should tilt left.

(6) Rotate TURN knob to center detent position. Control wheels should return to center position. Aileron flight tabs should return to neutral positions. Left-hand spoilers should return to streamline positions. AIL trim bar should center.

(7) Rotate TURN knob far enough clockwise to rotate control wheels about five degrees to the right.

WARNING: WARN EVERYBODY TO LEAVE WING FLAP AREA BEFORE LOWERING FLAPS FOR THE FOLLOWING TESTS.

(8) Unlock the flap control lever and actuate the lever to "20° Detent" position. Control wheels should increase travel to the right.

(9) Rotate TURN knob to detent position. Control wheels should center.

(6) Actuate autopilot altitude hold switch to ALT position. Switch should engage and remain in ALT position.

(7) Actuate flight director ALT HOLD switch to ON position. Switch should engage and remain in ON position.

(8) Press a control wheel disengage switch. Autopilot engage switch should return to OFF position, and altitude hold switch should disengage. Flight director mode selector switch and ALT HOLD switch should return to OFF positions. CMPTR OFF flags should appear on on pilot's and copilot's horizon direction indicators, and the command bars should swing out of sight on both indicators.

G. Test Autopilot Disengaged Warning Light.

(1) Actuate autopilot engage switch to DAMPER position.

(2) Manually actuate the engage switch to OFF position. Red autopilot off warning light on instrument panel near trim indicator should flash intermittently.

(3) Disengage autopilot system by control wheel disengage switch. Warning light should extinguish.

(4) Engage autopilot system in AUTOPILOT mode then manually actuate the engage switch to OFF position. Red autopilot off warning light should flash intermittently.

(5) Disengage the autopilot by a control wheel disengage switch. Warning light should extinguish.

H. Test Trim Indicator.

(1) Center control columns, control wheels, and rudder pedals.

(2) Engage autopilot system in AUTOPILOT mode.

(3) Push right-hand rudder pedal slowly forward with enough pressure to overpower the autopilot. RUD bar of trim indicator should move to left of center.

(4) Allow rudder bar and rudder pedals to center then overpower autopilot with left-hand rudder pedal. RUD bar should move to right of center.

(5) Allow rudder bar and rudder pedals to center.

(6) Rotate aileron control wheels slowly to right with enough force to overpower autopilot. AIL bar of trim indicator should tilt left from center.

(6) Repeat steps 1 through 5 with the mode selector successively in LOC-VOR, GS AUTO, and GS MAN positions. Mode selector switch should return automatically to MAN position from each of these positions when TURN knob is rotated clockwise or counterclockwise out of detent position.

(7) Disengage autopilot system by control wheel disengage switch.

E. Test Pitch Wheel Interlocks.

(1) Rotate pitch wheels toward DOWN for nose-down signal. Elevator flight tabs should move upward.

<u>NOTE:</u> Red elevator out-of-trim warning light may light momentarily if pitch wheels are rotated far enough to insert high rate of pitch change.

(2) Rotate pitch wheels toward UP to center elevator tabs.

(3) Rotate pitch wheels toward UP to insert a nose-up signal. Elevator flight tab should move down. Trim warning light may light momentarily.

(4) Center the elevator flight tabs by the pitch wheels.

(5) Engage altitude hold switch in ALT position.

(6) Rotate pitch wheels toward DOWN for nose-down signal. Elevator flight tabs should not move.

(7) Rotate pitch wheels toward UP for nose-up signal. Elevator flight tabs should not move.

(8) Disengage autopilot by control wheel disengage switch. Engage switch and altitude hold switch should both disengage.

F. Test Interlocks with Flight Director System.

(1) Engage the autopilot system in AUTOPILOT mode.

(2) Actuate the mode selector switch of the flight director system to HDG position. CMPTR OFF warning flag should disappear from pilot's and copilot's horizon direction indicators, and yellow command bars should appear on both indicators.

(3) Actuate flight director ALT HOLD switch to ON position. The switch should hold in ON position.

(4) Actuate autopilot altitude hold switch to ALT position. Switch should not hold in ALT position.

(5) Actuate flight director ALT HOLD switch to OFF position.

(10) Rotate control panel TURN knob clockwise out of center detent position.

(11) Actuate engage switch to DAMPER position. Switch should hold in DAMPER position.

(12) Disengage autopilot by control wheel switch.

(13) Actuate engage switch to AUTOPILOT position. Switch should not hold in AUTOPILOT position but should return to OFF position when released.

(14) Center the TURN knob, then rotate the knob counterclockwise out of detent position.

(15) Actuate engage switch to DAMPER position. Switch should hold in DAMPER position.

(16) Disengage autopilot by control wheel switch.

(17) Actuate engage switch to AUTOPILOT position. Switch should not engage but should return to OFF position when released.

(18) Engage autopilot engage switch in AUTOPILOT position.

(19) Rotate the mode selector switch in turn to HDG, LOC-VOR, GS AUTO, and GS MAN positions. Mode selector switch should remain in each of these positions when released.

(20) Disengage the autopilot by control wheel switch and reengage the engage switch in DAMPER position.

(21) Rotate mode selector to all positions as in step 19. Mode selector switch should engage in all positions.

(22) Disengage autopilot by control wheel switch.

D. Test TURN Knob Interlocks.

(1) Engage autopilot engage switch in AUTOPILOT position.

(2) Engage mode selector switch in HDG position.

(3) Rotate TURN knob clockwise out of detent position. Mode selector switch should return automatically to MAN position.

(4) Center TURN knob in detent position and reengage mode selector switch in HDG mode.

(5) Rotate TURN knob counterclockwise out of detent position. Mode selector switch should return automatically to MAN position.

(e) PILOT NAV INSTR AMP

(f) PILOT and COPILOT REMOTE COMPASS

(g) ELEC COMPT FAN CONT

(h) AUTOPILOT STAB TRIM CONTROL

(i) MASTER WARN LT & CONTROL

(j) MAST WARN

(k) SPEED STABILITY

(l) STAB TRIM RATE CONT

(m) STAB POSITION IND

(n) FLIGHT DIRECTOR

C. Test Autopilot Interlocks.

(1) Actuate the engage switch to DAMPER and AUTOPILOT positions. Switch should not hold in either position.

(2) Actuate the altitude hood switch to ALT position. Switch should not hold in ALT position when released.

(3) Rotate the MODE SELECTOR switch successively to HDG SEL, LOC-VOR, and GLIDE PATH positions. Switch should not remain in those positions but should spring back to MAN position when released.

(4) Actuate the PITCH knob toward DOWN and then toward UP positions. Pitch knob should return to center detent position from either position when released.

(5) Rotate the TURN knob from center detent position. TURN knob should remain in the position in which released. Return the knob manually to center detent position.

(6) Close COPILOT NAV INST AMP, YAW DAMPER, and AUTOPILOT circuit breakers, and start the stop watch.

(7) Immediately actuate the engage switch to DAMPER position. Switch should engage in DAMPER position.

(8) Actuate the engage switch to AUTOPILOT position. Switch should not engage in AUTOPILOT position before 50 seconds have passed from closing the COPILOT NAV INST AMP circuit breaker, but should engage within 96 seconds. Delay is caused by vertical gyro erection time.

(9) Disengage the autopilot by pressing the control wheel disengage switch.

AUTOPILOT SYSTEM - ADJUSTMENT/TEST

1. Adjustment/Test Autopilot System

A. Equipment Required.

(1) External ac power unit.

(2) Pitot-static test stand.

(3) Gables G-250A ILS test set.

(4) Collins 479U-1 VOR line test cart.

(5) Spring scale, 0 to 150 pounds.

(6) Rudder, aileron, and elevator battens.

(7) Stop watch.

(8) Precision volt-ohmmeter.

B. Preparation.

(1) Connect external ac power to the airplane.

(2) Install control surface battens to hold rudder, aileron, and elevator surfaces in streamline position.

(3) Connect pitot pressure line of pitot-static pressure stand to pitot pressure probe on right-hand side of airplane.

(4) Set up both radio signal generator test sets about ten feet in front of the airplane and power them. Adjust the 479U-1 signal generator to a frequency of 332.0 mc. Actuate the AUTO/MANUAL switch of the G-250A test set to MANUAL position.

(5) Actuate the HYD PUMP switch on the flight engineer's panel to ON position.

(6) Actuate the STAB TRIM HYD SHUTOFF switch on the pedestal to OPEN position.

(7) Close the following circuit breakers:

(a) PILOT & RADIO RACK DC and COPILOT & FLT ENG DC AUDIO SELECT

(b) NO. 1 AC and NO. 2 AC GLIDE SLOPE

(c) NO. 1 AC, NO. 1 DC, NO. 2 AC, and NO. 2 DC VHF NAV

(d) NO. 1 AC and NO. 2 AC NAV INST BUS TRANS

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
9. AUTOPILOT SYSTEM ENGAGES IN AUTOPILOT BUT NOT IN DAMPER MODE	
A. AUTOPILOT-DAMPER switch faulty.	Replace autopilot control panel.
B. Rudder servo faulty.	Remove access plate and check for fixed phase and variable phase voltages at rudder servo. If voltages are normal, replace rudder servo.
C. Wiring defective.	If voltages at rudder servo are not normal, check continuity of wiring to rudder servo. Repair or replace defective wiring.
10. WARNING LIGHT REMAINS ON WHILE AUTOPILOT IS ENGAGED	
A. Airplane 28-volt dc power lost.	Close MASTER & WARN LT CONT circuit breaker on main circuit breaker panel in flight compartment. If light does not extinguish, check for voltage on 28-volt dc emergency bus. If there is voltage on the bus, wiring from the bus to the circuit breaker may be defective.
B. Relay operation faulty.	Replace warning light power relay K1. Replace warning light relay K9.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
5. MODE SELECTOR SWITCH DOES NOT HOLD ON GS AUTO SELECTION	
A. Glide slope arm relay not energized.	Replace automatic engage amplifier card SA-127-A1 in J10 in amplifier-computer.
	Replace localizer relay K10.
	Replace glide slope arm relay K6.
	Replace autopilot control panel.
6. MODE SELECTOR SWITCH DOES NOT HOLD ON GS MANUAL SELECTION	
A. Glide slope engage relays not energized.	Turn control knob on autopilot control panel not in detent position.
	Replace localizer relay K10 in amplifier-computer.
	Replace localizer - VOR relay K-18.
	Replace autopilot control panel.
7. WARNING LIGHT DOES NOT FLASH WHEN AUTOPILOT DISENGAGES AUTOMATICALLY	
A. Warning light lamp burned out.	Push to test. Replace faulty lamp.
B. Warning light flasher faulty.	Replace faulty flasher units.
C. Wheel disconnect switches faulty.	Test continuity through control wheel disengage switch circuits. Replace faulty switches or repair defective wiring.
D. Relay operation faulty.	Replace warning light relay K9 in amplifier-computer.
	Replace rudder engage relay K17 in amplifier-computer.
8. WARNING LIGHT ILLUMINATES STEADILY WHEN AUTOPILOT DISENGAGES AUTOMATICALLY	
A. Relay faulty.	Replace rudder engage relay K17 in amplifier-computer.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
3. AIRPLANE DOES NOT RESPOND TO GLIDE SLOPE SIGNAL	
A. Glide slope received faulty.	Try operation with second glide slope receiver. Check operation of receiver. Replace defective glide slope receiver.
B. Glide slope engage relay not energized.	Make sure that turn control knob on control panel is in detent position.
	Replace amplifier card SA-127-A1 in J10 in amplifier-computer.
	Replace autopilot engage relay K12 in amplifier-computer.
	Replace localizer relay K10 in amplifier-computer.
	Replace autopilot control panel.
C. Air data sensor faulty.	Check potentiometer continuity through pins X, Y, and Z of air data sensor receptacle. If no continuity, replace air data sensor.
4. DAMPER MODE DOES NOT ENGAGE	
A. Interlocks not satisfied.	Close AUTOPILOT circuit breaker on main circuit breaker panel in flight compartment.
	Check voltage on all three phases of pilot's ac essential bus.
	Replace autopilot control panel.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. AUTOPILOT SYSTEM DOES NOT ENGAGE	
A. Interlocks not satisfied.	Close AUTOPILOT and VERT GYRO NO. 2 circuit breakers on main circuit breaker panel in flight compartment.
	Check for voltage on all three phases of pilot's ac essential bus.
	Check for burned-out fuse on front panel of autopilot power junction box.
	Replace autopilot engage interlock relay K34 in amplifier-computer.
	Replace rudder engage relay K17 in amplifier-computer.
	Check continuity through control wheel disengage switches.
	Replace autopilot control panel.
B. Vertical gyro not erected.	Wait approximately two minutes after electrical power is turned on. Replace vertical gyro if gyro does not erect and close interlock switch.
2. ALTITUDE HOLD SWITCH DOES NOT DISENGAGE WHEN GLIDE SLOPE MANUAL MODE IS SELECTED	
A. Glide slope relay not energized.	Replace autopilot engage relay K12 in amplifier-computer.
	Replace glide slope engage relay K22 in amplifier-computer.
	Replace altitude hold relay K13 in amplifier-computer.
	Replace autopilot control panel.

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CHAPTER 23

COMMUNICATIONS - DESCRIPTION AND OPERATION

1. General

The communications systems comprise provisions for two high frequency radio communications systems, two VHF radio communications systems, a two-channel selective calling system (SELCAL), a public address system, a flight and service interphone system, a tape reproducer unit, and a passenger call system.

Controls for the radio communications systems are located in the flight compartment on the pilots' pedestal and side consoles, and at the flight engineer's position. Figure 1 shows the arrangement of control panels on the pedestal and consoles. Interphone and public address system controls are located in the flight compartment and in the passenger cabin. Jacks and jackboxes are provided in the flight compartment, in the electronics compartment, in the wheel wells, and in the pylons and other service areas of the airplane.

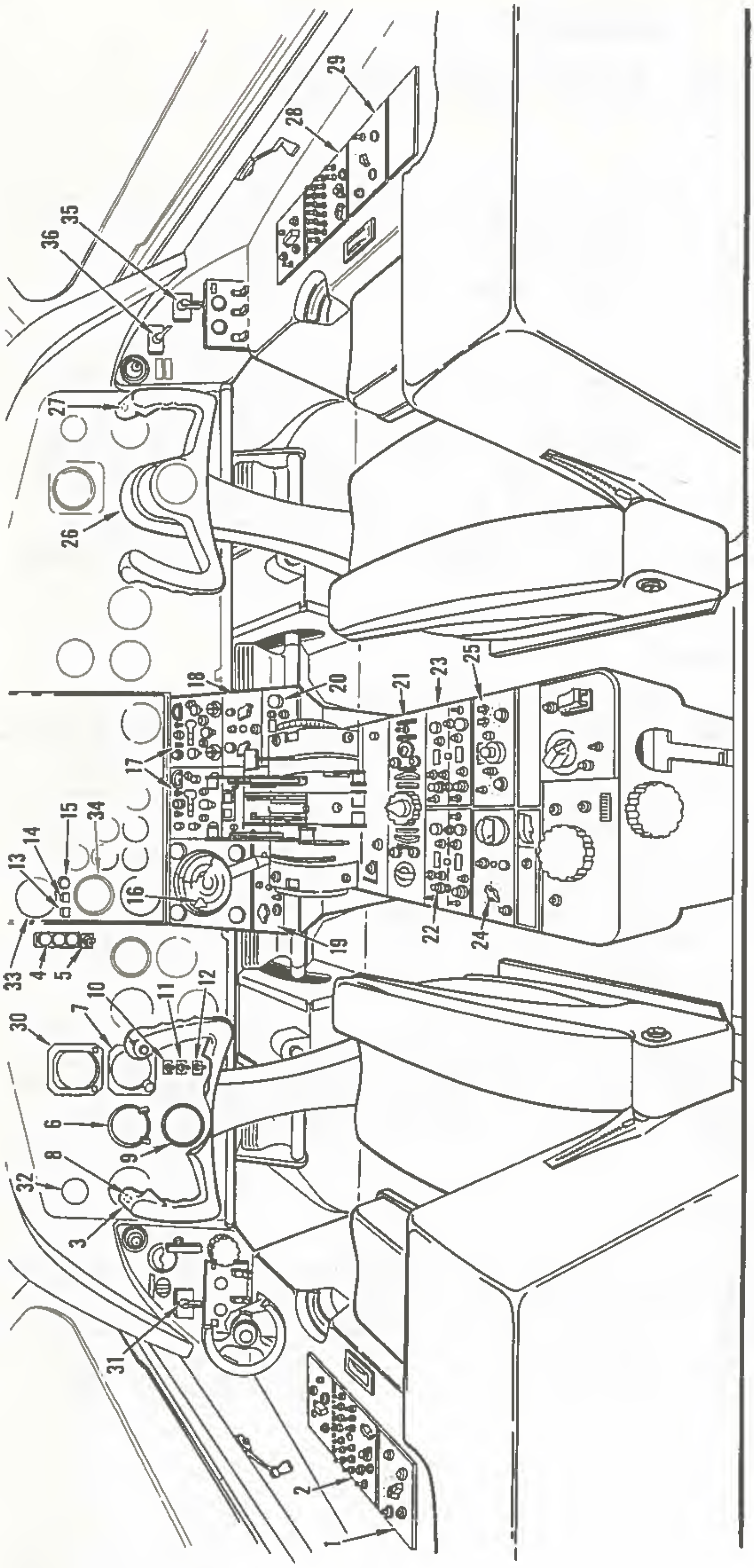
2. Electronic Equipment Ventilation

Electronic equipment is cooled by air drawn in through perforations and louvers in the tops and sides of units installed in the electronics compartment racks. Conditioned air from the flight and passenger compartments flows into the electronics compartment, through the electronics equipment, and aft into the electrical compartment. Permissible temperatures in the three compartments are successively higher. The amount of air drawn through the electronic racks is metered and controlled by apertures in the rack shelf ducts. After passing through the cooling electronic units, air is ducted to the electrical compartment and then flows overboard through the forward pressure regulator and outflow valve.

Circulation of air in flight is maintained by creating a low pressure in the electrical compartment. When the airplane is on the ground, a blower in the system maintains cooling airflow through electronic equipment. For a detailed explanation of the electronic compartment cooling refer to Chapter 21, AIR-CONDITIONING.

3. Electronic Equipment Installation

Radio receivers, radio transmitters, the tape reproducer, and audio amplifiers of the interphone and public address systems are installed on vibration-protected shelves in racks in the right and left sides of the electronics compartment. This compartment, which is located below the flight compartment floor, is accessible in flight through a door in the



1. PILOT'S MICROPHONE SELECTOR PANEL
2. PILOT'S AUDIO SELECTOR PANEL
3. PILOT'S CONTROL COLUMN
4. MARKER BEACON INDICATOR LIGHT PANEL
5. MARKER BEACON SENSITIVITY CONTROL SWITCH
6. RADIO MAGNETIC INDICATOR
7. COURSE DEVIATION INDICATOR
8. AUTOPILOT DISENGAGE SWITCH
9. OMNI-BEARING INDICATOR
10. DEVIATION-VOR SELECTOR SWITCH
11. CDI AND A/P SELECTOR SWITCH
12. KIFIS TEST SWITCH
13. AUTOPILOT DISENGAGED INDICATOR LIGHT
14. ELEVATOR OUT-OF-TRIM INDICATOR LIGHT
15. GLIDE SLOPE ARMED INDICATOR LIGHT
16. SEARCH-WEATHER RADAR INDICATOR
17. ADF CONTROL PANELS
18. SELCAL CONTROL PANEL
19. SEARCH-WEATHER RADAR CONTROL PANEL
20. HF COMMUNICATIONS RADIO CONTROL PANEL
21. AUTOPILOT CONTROL PANEL
22. VHF-VOR NO. 1 CONTROL PANELS
23. VHF-VOR NO. 2 CONTROL PANELS
24. PUBLIC ADDRESS CONTROL PANEL
25. ATC TRANSPONDER CONTROL PANEL
26. COPILOT'S CONTROL COLUMN
27. AUTOPILOT DISENGAGE SWITCH
28. COPILOT'S AUDIO SELECTOR PANEL
29. COPILOT'S MICROPHONE SELECTOR PANEL
30. HORIZON DIRECTOR INDICATOR
31. STATIC PRESSURE SOURCE SELECTOR
32. TRUE AIRSPEED INDICATOR
33. STATIC AIR TEMPERATURE INDICATOR
34. AUTOPILOT TRIM INDICATOR
35. STATIC PRESSURE SOURCE SELECTOR
36. PITOT-STATIC AUXILIARY EQUIPMENT SHUTOFF VALVE CONTROL

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Control Panels and Indicators
Figure 1

floor of the forward coat closet and on the ground through an exterior door aft of the nose wheel well. Figure 2 shows the location of electronics compartment racks and equipment. The SELCAL unit is accessible for setting selective calling system code channels through an opening in the aft left bulkhead of the flight compartment.

Units of equipment of communications systems are rigidly mounted on the vibration-protected shelves. This method of installation saves space and weight; no space needs to be left between units to permit vibration on individual shockmounts, and shelves are lighter than individual shock-mounts.

4. Communications Systems Control Panels

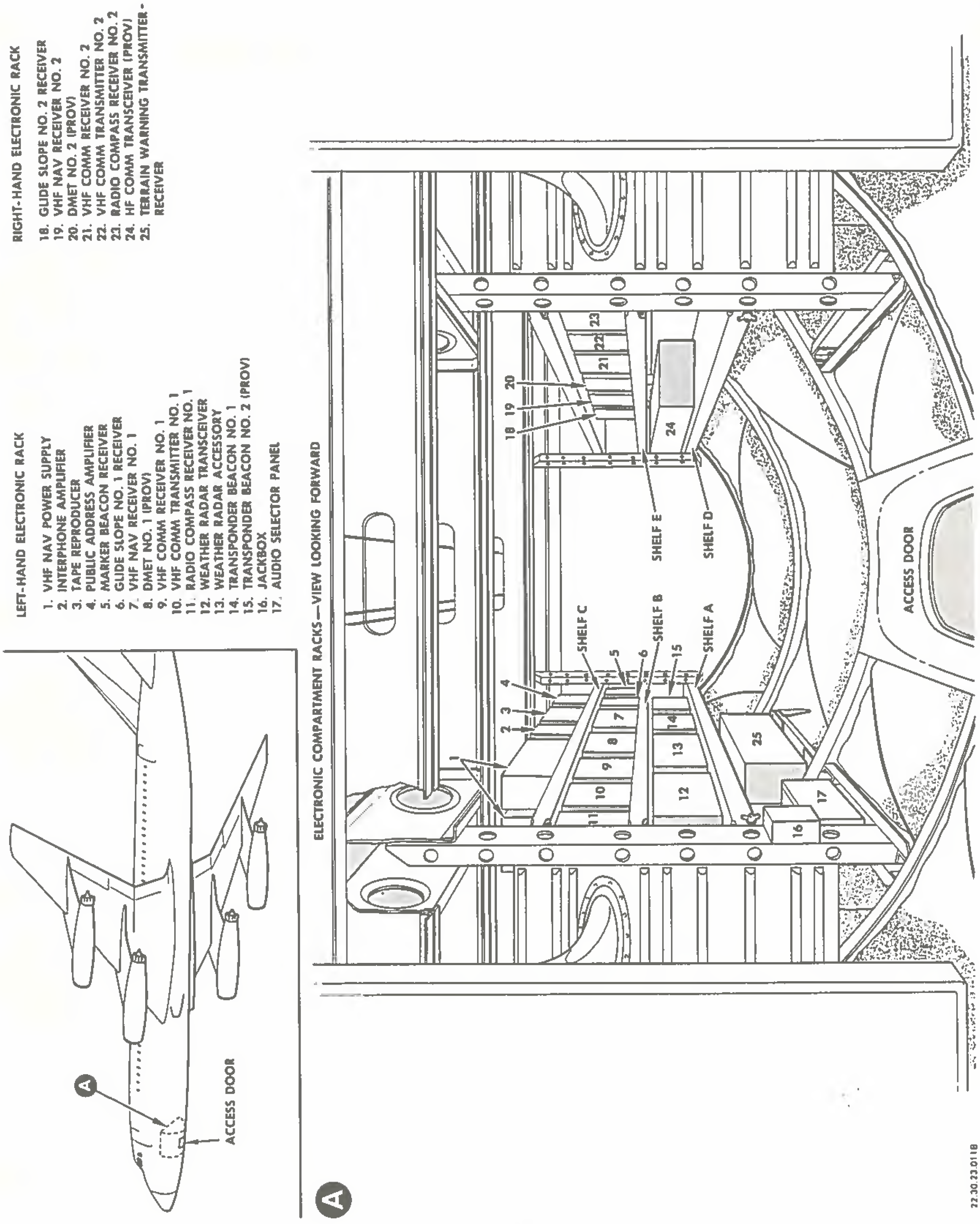
Control panels whose functions are confined to specific systems are described with their systems. The radio power control panel, which is common to all electronics systems, is described in the following paragraphs.

A. Radio Power Control Panel. The radio power control panel is installed on the overhead panel in the flight compartment. This panel controls electrical power to all radio communications equipment. See Figure 3 for an illustration of the panel. The ESSENTIAL switch energizes the relay that connects ac and dc power to the essential radio bus. The NORMAL switch controls electrical power to No. 1 and No. 2 normal ac and dc radio buses. Figure 4 illustrates the radio power distribution system.

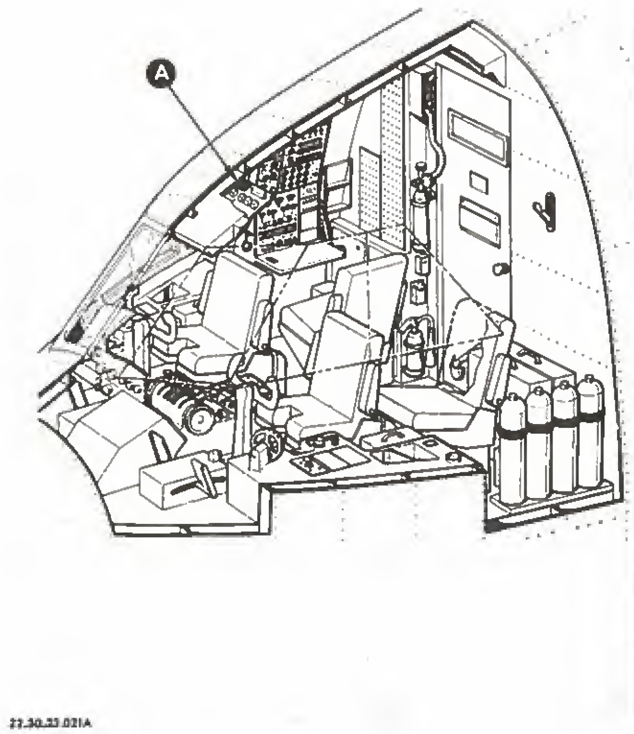
If these switches or the relays that are energized by these switches malfunction, essential ac and dc power circuits can be completed by closing two OVERRIDE circuit breakers on the flight compartment main circuit breaker panel.

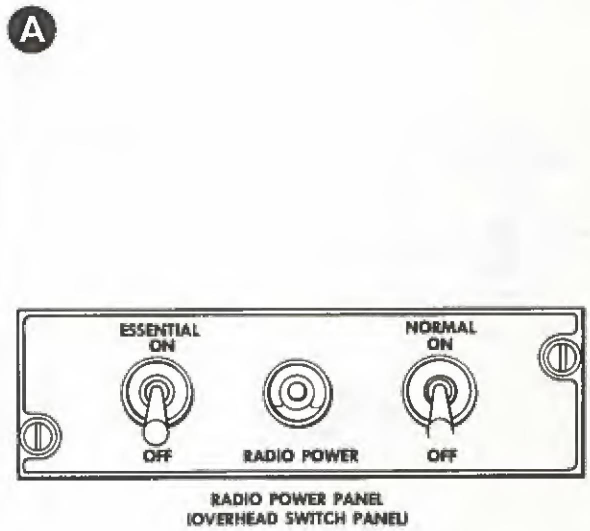
5. Static Dischargers (see Figure 5)

Radio interference caused by corona buildup, precipitation and other natural phenomena, is reduced by static dischargers on the wing tips and stabilizers. Nine static dischargers are mounted on each wing tip; six on each horizontal stabilizer; and five on the vertical stabilizer. The static discharger blades are removed from their mounting bases by loosening a set screw in the base. Refer to maintenance practices, Section 23-0 for removal/installation procedures.

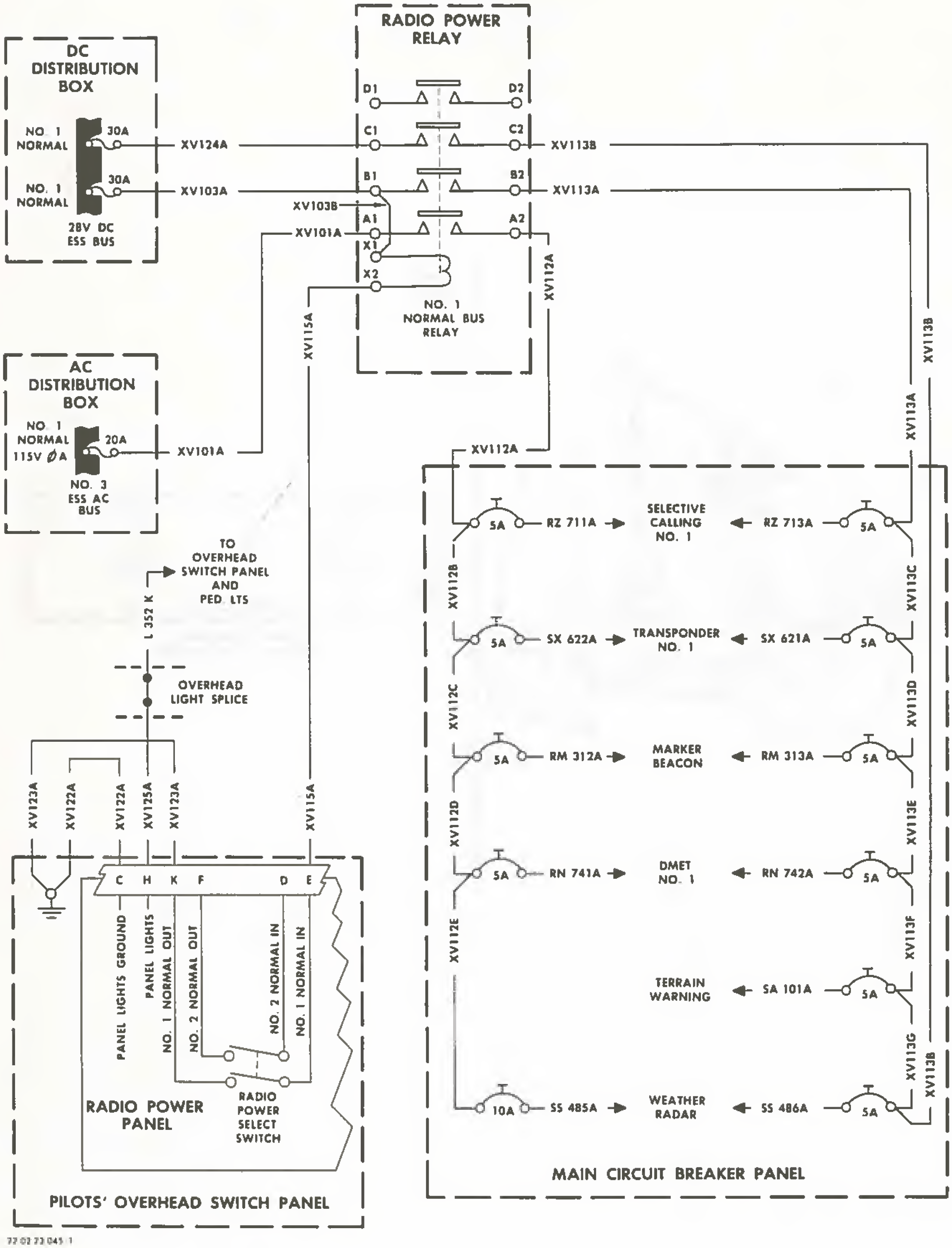


Electric Compartment Racks
Figure 2

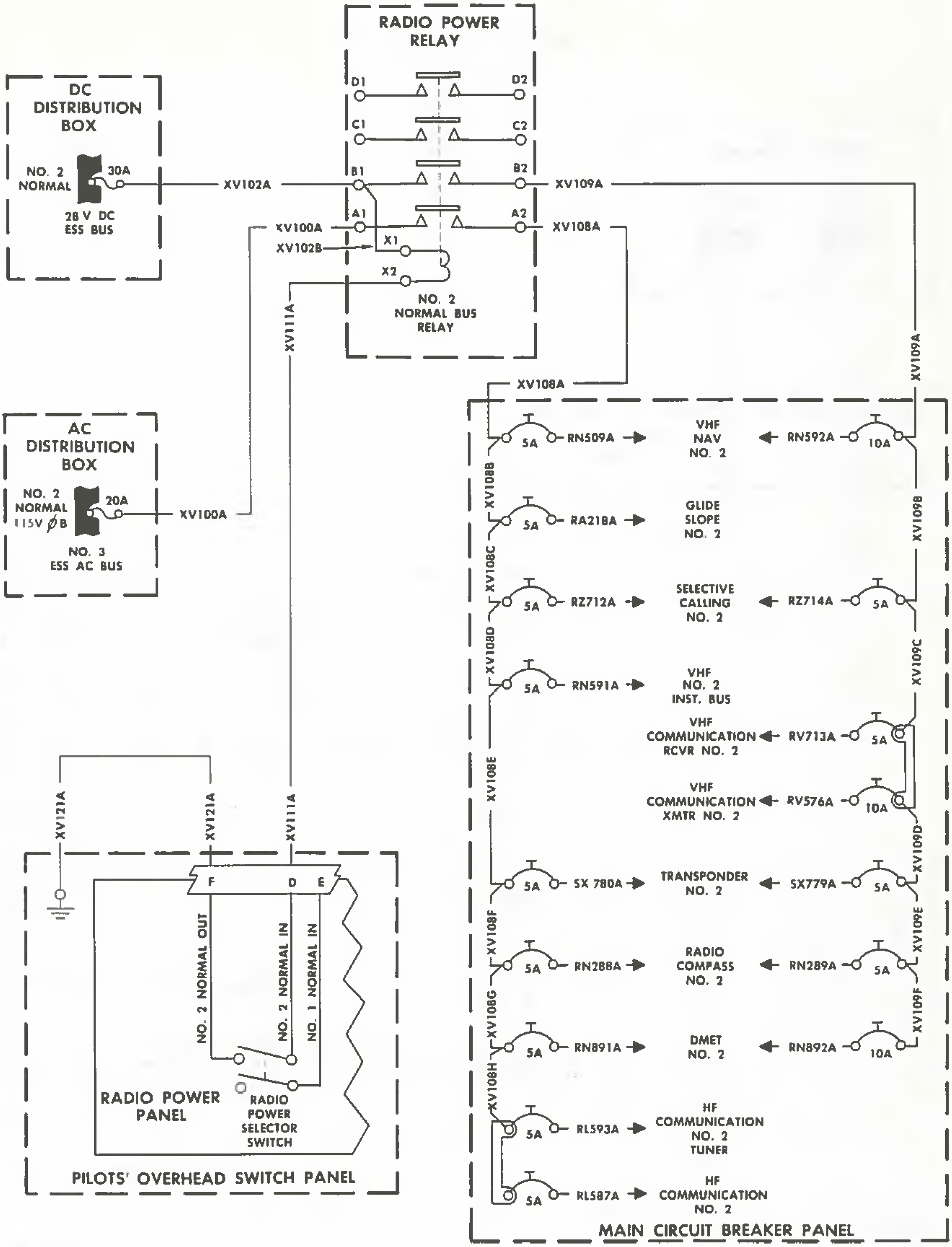




Radio Power Control Panel
Figure 3



Radio Power Distribution System
Figure 4 (Sheet 1 of 4)



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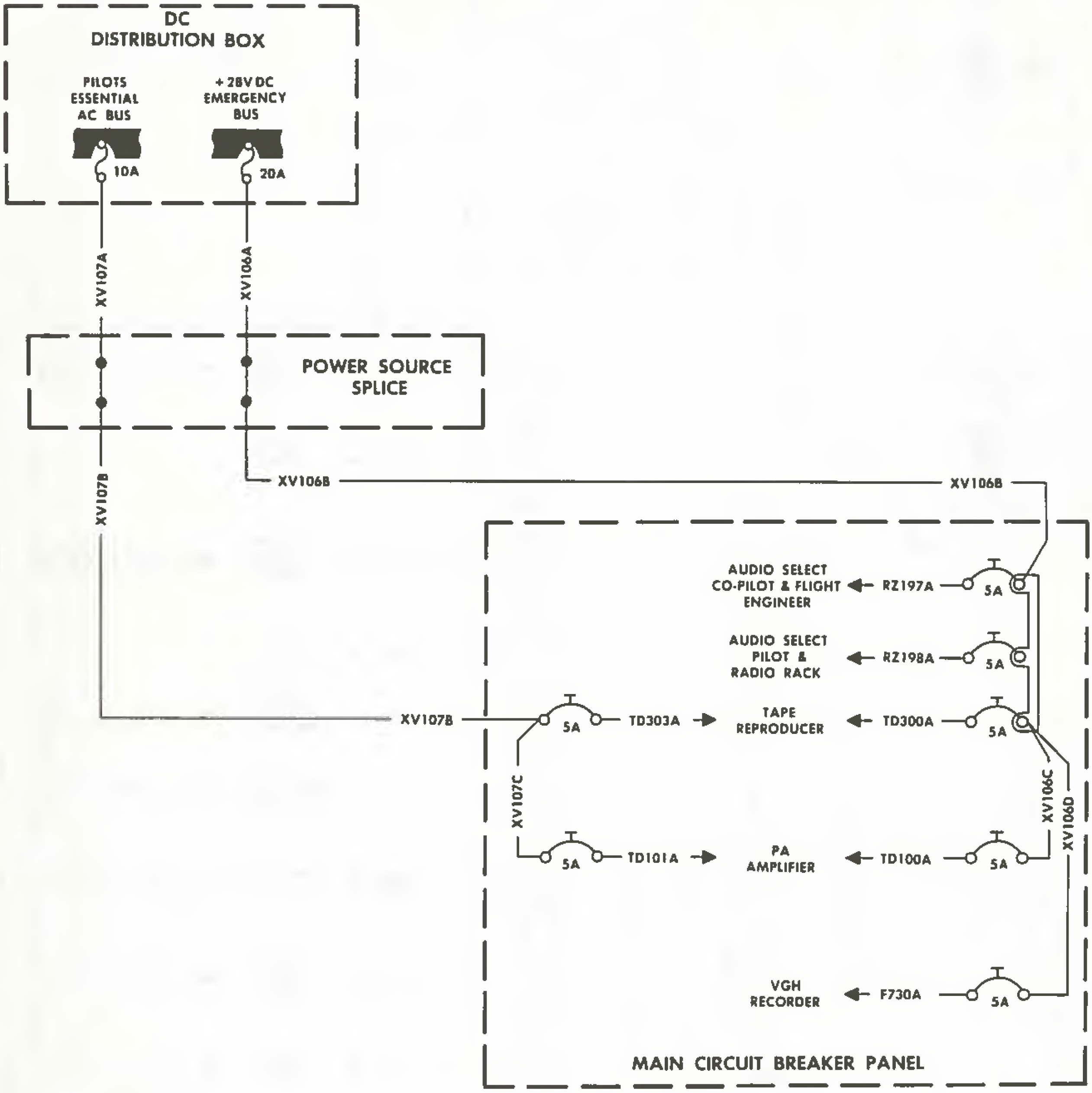
Radio Power Distribution System
Figure 4 (Sheet 2 of 4)



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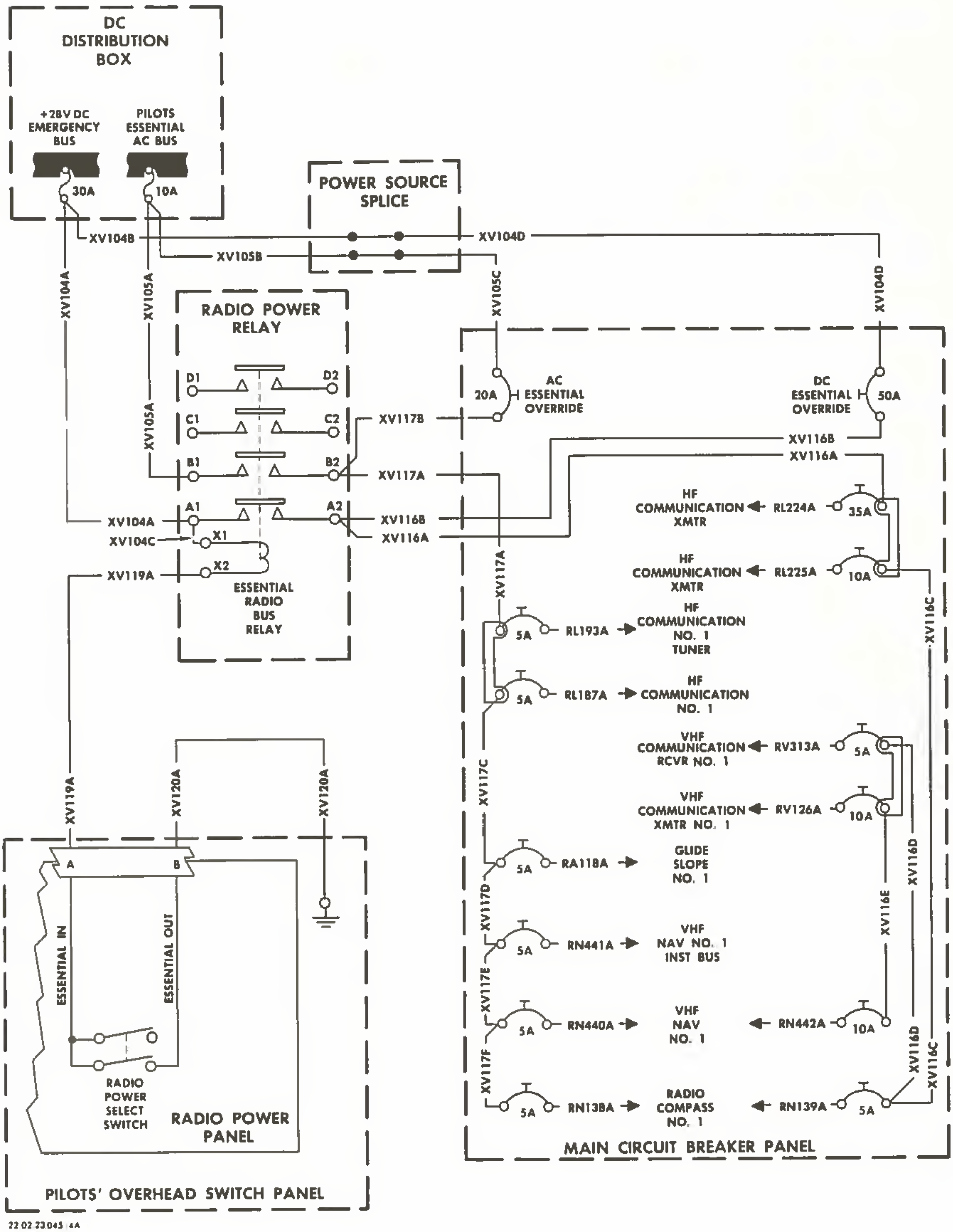
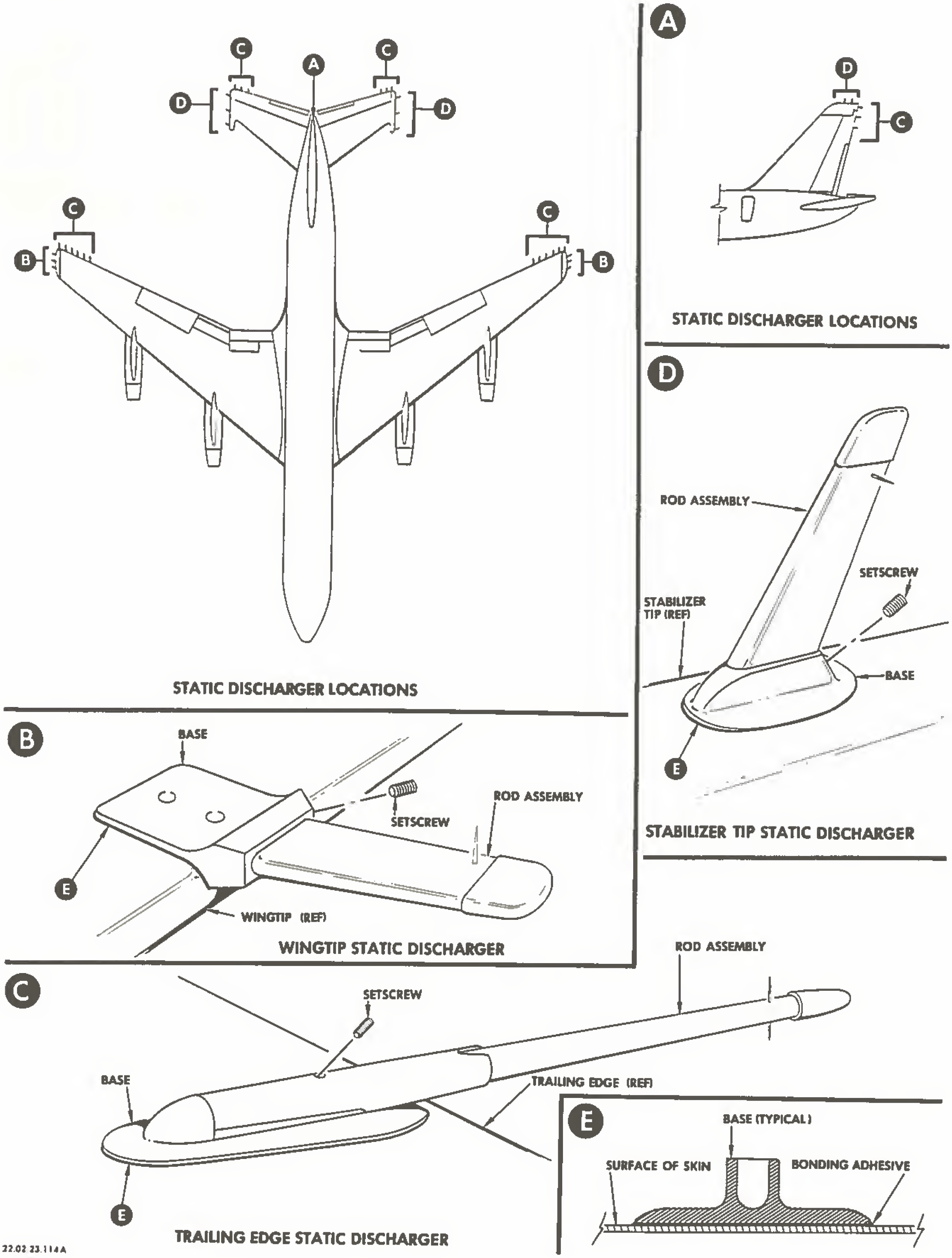
Radio Power Distribution System
Figure 4 (Sheet 3 of 4)



Radio Power Distribution System
Figure 4 (Sheet 4 of 4)



Static Discharger Locations
Figure 5

COMMUNICATIONS SYSTEMS - MAINTENANCE PRACTICES

1. General

A. When testing any communications system on the ground, external power must be connected to the airplane if no airplane generators are operating.

B. The most important communications systems are duplicated, or have duplicate components and trouble shooting may be readily accomplished by substituting operative units for apparent faulty units.

C. When any component is removed from a system, all ports or openings should be covered to prevent entrance of dirt or any other foreign material. Plugs and receptacles should be covered to prevent corrosion or dirtying of contacts. Plastic bags (polyethylene) are excellent covers for plugs and receptacles.

D. When components are removed from the electronic equipment rack, the cooling air ports in the electronic rack shelves should be covered to prevent foreign material from entering the cooling system.

CAUTION: BE SURE ALL DUCTS, PLUGS OR COVERS ARE REMOVED FROM COOLING AIR PORTS BEFORE INSTALLING EQUIPMENT. IF PORTS ARE BLOCKED, EQUIPMENT MAY OVERHEAT. USE ONLY AN APPROVED GROUND POWER UNIT FOR GROUND OPERATION OR TESTING.

E. When trouble shooting or checking communication equipment channeling, be sure to approach the frequency involved from both higher and lower frequencies in order not to reach a false assumption that the channeling is normal. Due to the rather close and critical spacing of the contacts on channel selector switch wafers in the control units, a bent contact or "play" between the switch shaft flats and the wafer may allow the unit to channel properly going up in frequency but not going down in frequency or vice versa.

2. Testing Bonding Installations

A. Radio communications are seriously impaired by precipitation static interference under some flight conditions if a poor electrical bonding condition is developed between portions of the airplane structure. For this reason it is imperative that the electrical bonding installations be maintained in accordance with the following instructions:

(1) The junction of the bonding terminal to the surface to which it is fastened must be free of dirt, paint, and corrosion, and the connections must be mechanically secure.

(2) The bonding jumper shall be in good physical condition, and shall be replaced if it is broken, frayed or corroded. Missing bonding jumpers shall be replaced.

3. Removal/Installation of Static Dischargers (see Figure 201)

A. Equipment Required.

(1) One-ounce adhesive kit No. 610-1016, Granger Associates.

(2) Aluminum oxide sandpaper, No. 400 grit.

(3) A-202 epoxy paint stripper, Cee Bee Chemical Co.

(4) Aluminum bonding strap 5 inches by 1.5 inches by 0.020 inch.

(5) Methyl ethyl ketone solvent.

(6) No. 361 high temperature glass fabric adhesive tape.

(7) Protractor with adjustable arm.

(8) Infrared heat lamps, 250 watts, and stands.

(9) Torque tool No. 610-1014 with TUWR 1J9530 adapter, Granger Associates.

(10) Wheatstone bridge.

(11) Megger.

B. Prepare for Static Discharger Installation.

(1) Mark locations of static discharger bases on wingtips, fintip, and tips of horizontal stabilizer as shown in Figure 201. Position stabilizer static discharger bases on chord centerlines of horizontal and vertical stabilizers.

(2) Position trailing edge dischargers as follows:

(a) Streamline adjustable arm of protractor by setting arm to angle of rudder or elevator end or by setting arm to angle of wing structure.

(b) At locations shown in Figure 201, mark reference lines on paint or skin. Make reference lines longer than base mounting areas and use reference lines to align discharger bases.

(3) Strip paint from discharger base mounting areas. Refer to Chapter 51, STRUCTURES GENERAL, for paint removal instructions. Use discharger bases as templates to mark off areas to be cleaned.

(4) Sand base mounting areas bright with aluminum oxide sandpaper.

(5) Sand bottom surfaces of static discharger bases bright with sandpaper.

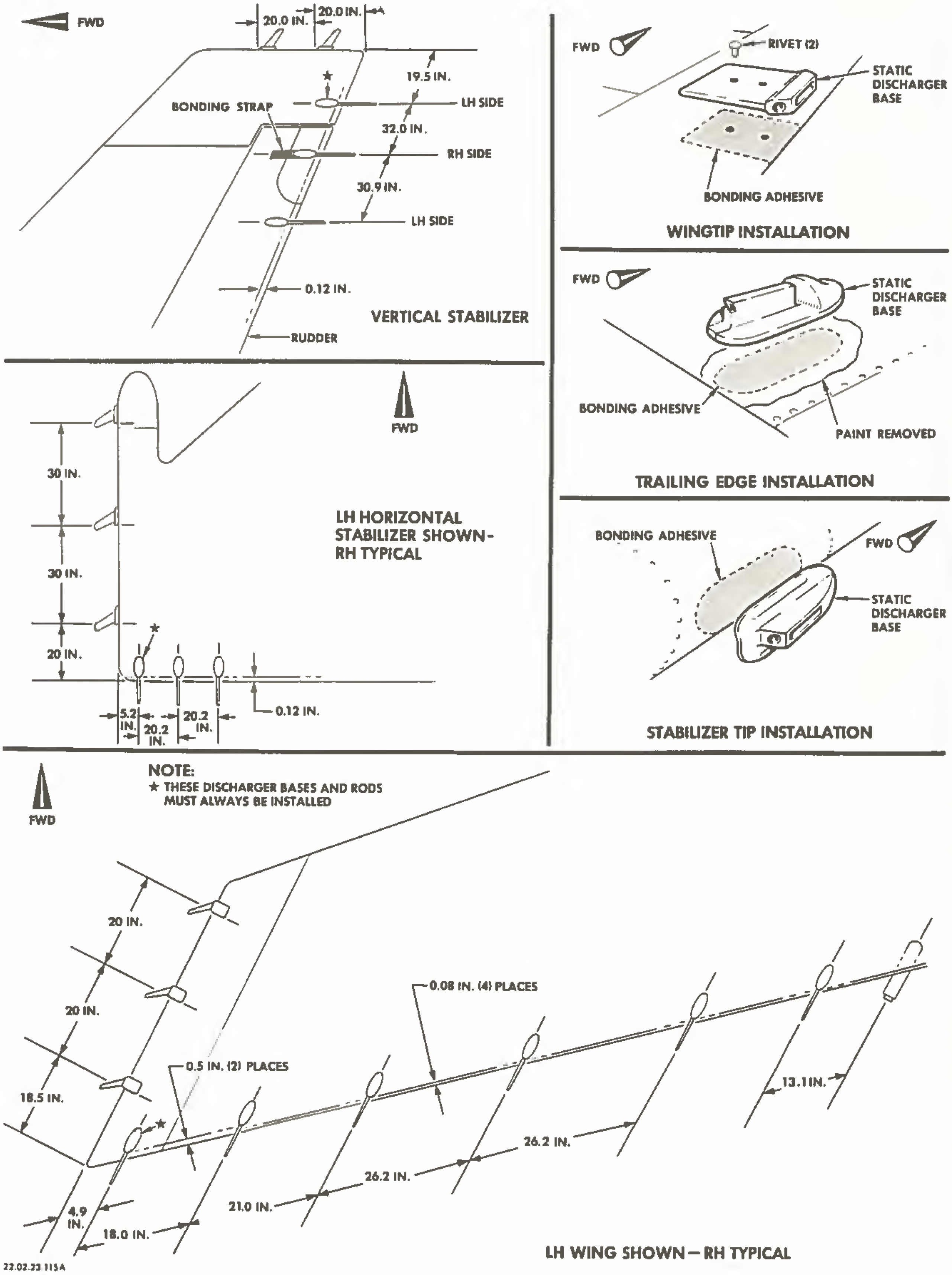
TEMPORARY REVISION NO. 23-4.

Insert facing 23-0, Page 202, dated Mar. 22/62.

Add new note following paragraph 3.B. as shown below:

B. Prepare for Static Discharger Installation.

<u>NOTE:</u> Replacement static discharger bases may be either plated or unplated (plated bases are identified by a green dot). Only unplated discharger bases should be sanded before applying adhesive. Time interval between sanding discharger base or base mounting area and applying adhesive should not exceed 30 seconds.



Static Discharger Installations
Figure 201

(6) Prepare bonding adhesive by mixing resin and hardener of adhesive kit. Follow mixing instructions with kit. Prepared adhesive has working life of about two hours at standard room temperature, shorter at higher temperatures.

C. Install Trailing Edge and Stabilizer Tip Static Discharger Bases on Metal Skin.

(1) Have cut strips of adhesive tape ready for use.

(2) Install trailing edge discharger bases as follows:

(a) Clean prepared and polished base mounting area with solvent on cheesecloth.

(b) Clean polished base of static discharger with solvent.

(c) Make sure that base and mounting area are dry.

(d) Apply thin layer of bonding adhesive mixture to bottom of base.

(e) Position base on mounting surface with light pressure. Slide base about slightly to distribute adhesive evenly. Align center of base with reference line.

(f) Wipe off bonding adhesive squeezed from under discharger base, but leave an unbroken fillet of adhesive around edge of discharger base.

(g) Place strip of adhesive tape across forward end of base. Then streamline base exactly by placing protractor arm along center ridge of base. With base in streamline position, place second strip of adhesive tape across aft end of discharger base to keep base from sliding.

(h) Set up heat lamp on stand about 6 inches above discharger base and apply heat for 20 minutes. Adjust height of heat lamp to raise temperature of work area to 200 degrees F.

(i) Remove heat lamp and test fillet of bonding adhesive with screwdriver blade or back of knife blade with light pressure. If adhesive tests hard, adhesive will finish curing in 24 hours at normal temperatures.

(3) Install stabilizer tip static discharger base.

(a) Polish and clean mounting areas and bottom of discharger base.

(b) Apply thin layer of bonding adhesive to discharger base, press base to mounting area, wipe away adhesive from around base, and fasten base to stabilizer tip with adhesive tape. Leave fillet of adhesive all around edges of base.

(c) Cure bonding adhesive 20 minutes with heat lamp.

D. Install Rudder Static Discharger Base on Fiber Glass.

CAUTION: EPOXY PAINT STRIPPER AND METHYL ETHYL KETONE SOLVENT CAN DAMAGE FIBER GLASS. USE BOTH SPARINGLY WHILE PREPARING FIBER GLASS SURFACES FOR STATIC DISCHARGER BASE. ALSO AVOID APPLYING ENOUGH HEAT TO BLISTER FIBER GLASS WHILE CURING BONDING ADHESIVE.

(1) Remove paint from discharger base mounting area on left-hand side of upper end of rudder. Use both paint stripper and solvent sparingly. Fiber glass does not need to be polished, but be sure that mounting area is clean and dry.

(2) Remove paint from strip wide enough to take aluminum bonding strap. Bonding strip area must extend about 1 inch into metal skin surface of rudder.

(3) Have cut strips of adhesive tape ready for use.

(4) Clean prepared area of rudder and one side of aluminum bonding strap with solvent.

(5) Apply thin layer of adhesive bonding mixture to prepared side of aluminum bonding strap.

(6) Press bonding strap in place and wipe away bonding adhesive squeezed from beneath strap. Streamline bonding strap with protractor.

(7) Apply strips of adhesive tape to hold bonding strap in place.

(8) Clean upper surface of bonding strap in static discharger base mounting area with solvent.

(9) Polish bottom of discharger base with sandpaper and clean with solvent.

(10) Apply thin layer of bonding adhesive to bottom of discharger base.

(11) Set discharger base in position on aft end of aluminum bonding strap. Slide discharger base slightly to distribute bonding adhesive evenly.

(12) Wipe away adhesive squeezed from beneath discharger base, but leave unbroken fillet of bonding adhesive around base of discharger.

(13) Align static discharger base with protractor and apply strips of adhesive tape to hold base in place.

(14) Cure bonding adhesive of discharger base and aluminum bonding strap for 20 minutes with heat lamp. If bonding adhesive is then hard enough that light pressure with screwdriver blade or knife blade does not mark fillet, bonding adhesive will cure at normal temperatures in 24 hours.

<u>NOTE</u>: Aluminum bonding strap may be painted over; but do not paint discharger bases.

E. Install Wingtip Static Discharger Base.

(1) Remove two rivets from upper surface of wingtip at static discharger base locations. Wingtip discharger base attaches to wingtip by new rivets in these holes.

(2) Sand static discharger base mounting area bright with sandpaper.

(3) Sand bottom of discharger base bright with sandpaper.

(4) Clean discharger base and discharger base mounting area with solvent.

(5) Apply thin layer of bonding adhesive to discharger base.

(6) Rivet discharger base to wingtip.

(7) Wipe away bonding adhesive squeezed from beneath discharger base; but leave unbroken fillet of adhesive around edges of discharger base.

(8) Cure bonding adhesive for 20 minutes with heat lamp to harden fillet of bonding adhesive.

F. Inspect Static Discharger Bases.

(1) Make sure that fillet of bonding adhesive is intact all around discharger bases. Fill cracks or holes in fillets with bonding adhesive mixture. Fillets around bases should be moisture proof.

(2) Test strength of bonding adhesive with torque tool and adapter. Torque trailing edge discharger bases to 246 inch-pounds, Torque stabilizer tip discharger bases to 196 inch-pounds.

(3) If static discharger base breaks away under torque test, clean off bonding adhesive, reinstall discharger base, and cure bonding adhesive.

G. Test Electrical Bonding.

(1) Measure ohmic resistance between static discharger bases and airplane structure with Wheatstone bridge. Bonding resistance must not exceed 0.1 ohm.

<u>NOTE</u>: If bonding resistance measures more than 0.1 ohm, base can sometimes be brought into tolerance by cleaning side edges and adding new mixture to bonding adhesive fillet.

H. Test Static Discharger Pin Resistance.

(1) Install static discharger rods in discharger bases.

(2) Measure ohmic resistance between points of discharger rods and airplane structure with megger. Resistance should measure within following limits: trailing edge dischargers, 8 to 50 megohms; stabilizer tip dischargers, 5 to 30 megohms; wingtip dischargers, 4 to 35 megohms.

(3) If static discharger resistances measure out of tolerance, replace rods of faulty dischargers and retest.

I. Install Static Discharger Bases.

(1) Remove discharger base.

(a) Pry away bonding adhesive fillet from around discharger base with pointed teflon tool. Avoid indenting skin of honeycombed structures.

(b) Remove two rivets from wingtip discharger base.

(c) Pry or torque base from wing or stabilizer surface.

(2) Replace base lost in flight or removed.

(a) Sand metal or fiber glass surface clean with aluminum oxide sandpaper.

(b) Install static discharger base as instructed in paragraph C, D, or E.

J. Routine Maintenance of Static Dischargers.

(1) Replace static discharger rods for the following faults:

(a) Discharger pins broken.

(b) Discharger pins dull.

(c) Discharger rod cap severely peeled or eroded.

(d) Discharger pin resistance out of tolerance.

(e) Rods damaged by lightning.

(2) Replace static discharger bases for the following faults:

(a) Bases severely eroded or corroded.

(b) Base lost in flight.

(c) High bonding resistance cannot be repaired.

(d) Signs of corrosion in bonding adhesive.

(e) Base damaged by lightning.

(3) Straighten bent discharger pins. But pins must be sharp.

(4) Dispatch airplanes with no more than four static discharger rods missing, but with these limitations:

(a) No more than one missing from wingtips.

(b) No more than two missing from wing trailing edges.

(c) No more than one missing from tips of horizontal stabilizers.

(d) No more than two missing from trailing edges of horizontal stabilizers.

(e) No more than one missing from tip of vertical stabilizer.

(f) No more than one missing from trailing edge of vertical stabilizer.

(g) All five static discharger rods must be installed in trailing edge discharger bases at tips of wings and stabilizers.

HF COMMUNICATIONS RADIO - DESCRIPTION AND OPERATION

1. General

Provisions are made for the installation of two high frequency communications systems that provide voice communications in the frequency range from 2 to 18.5 mc. These systems will enable relatively long-range communications, not being limited by line-of-sight characteristics as is VHF equipment. Communications in the high frequency range, however, are sensitive to atmospheric disturbance and precipitation static.

HF communications system provisions are for two control panels that simultaneously select transmitter and receiver frequencies, two Collins 18S-4 transmitter-receivers, two power relays, two antenna relays, two antenna coupling controls, an antenna coupling assembly, and a high frequency communications antenna. Since both systems will use the same antenna, simultaneous operation will not be possible. Control panel space is provided on the right forward side of the pilots' pedestal. Space for the transmitter-receiver unit and the power and antenna relays is provided in the electronics compartment and for the coupler controls in the aft section of the airplane. The coupler assembly will be installed in the upper fin. The tip of the fin constitutes the high frequency antenna. The coupler assembly and the system is protected by a lightning arrestor on the coupler assembly.

The radio frequency circuits of the transmitter-receiver will connect to the antenna coupling units by coaxial cables of 52-ohms impedance. Figure 1 provides information about coaxial cable installations. The antenna coupler matches the 52-ohm impedance of the transmitter and receiver output and input to the high impedance of the fin tip antenna, and correctly loads the antenna for the various transmitter frequencies.

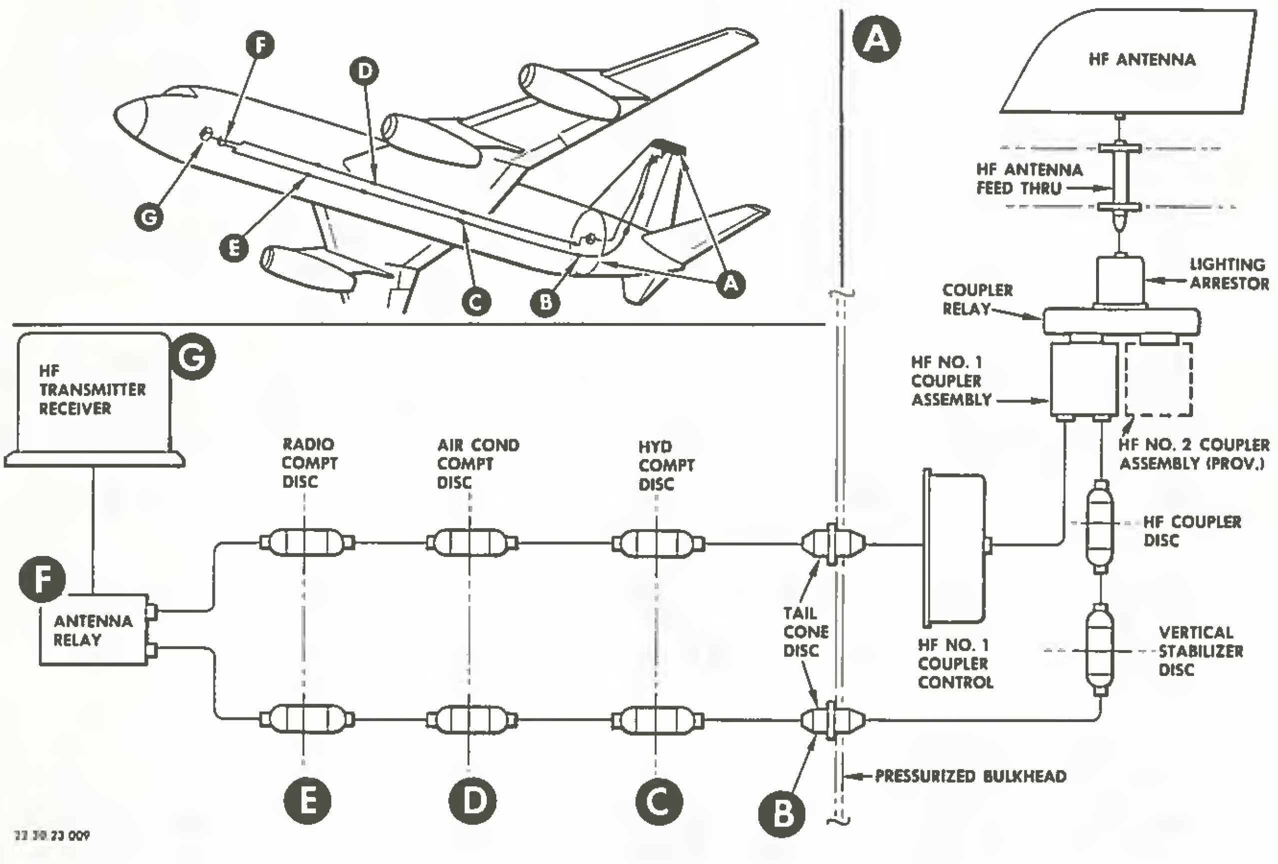
Channel selectors on the control panels select the frequency of operation. The selected channel appears in a window on the control panel. A volume control on the panel permits partial control of the audio level of the receiver output.

2. Power Requirements

The HF communications system requires about 30 watts ac power and 150 watts dc power. The pilot's ac essential bus supplies 115-volts ac through the essential radio bus relay. The 28-volt dc emergency bus supplies 28-volts dc through the essential radio bus relay.

3. Circuit Protection

The 115-volt ac circuits are protected by two 5-ampere circuit breakers. The 28-volt dc circuits are protected by one 35-ampere circuit breaker and one 10-ampere circuit breaker. These circuit breakers are located on the main circuit breaker panel.



HF Communications System Antenna Coaxial Cables
Figure 1

4. Control Panels

The operating frequency of HF communications radios is controlled remotely by the control panels. Microphone input to the communication system on which transmission is to be made, and receiver audio must be selected at the audio selector panel.

Selection of a frequency channel on the remote control panel tunes transmitter and receiver circuits to the desired frequency. After a new channel is selected time should be allowed for the selector mechanism to complete its cycle and the TUNE light to extinguish before the microphone switch is actuated. If the microphone switch is pressed before tuning is completed, the tuning operation ceases. Incomplete tuning may result in mismatch between transmitter and antenna, with drastic reduction in range. Maximum tuning time is about 20 seconds. Tuning is complete if receiver signals are received on the selected channel.

5. Transmitter-Receiver

The transmitter-receiver unit is housed in an aluminum case. The cover of the case is secured to the chassis by Dzus fasteners. The sides of the case are louvered for ventilation. The unit is held on the shelf by knurled nuts. Electrical connections except antenna are made through receptacles on the shelf. The antenna cable connects to a receptacle on the front panel of the unit. Two handles on the front panel facilitate carrying and installation. A microphone jack, a selector switch, and a meter on the front panel make it possible to check and adjust the transmitter at the unit.

The transmitter is crystal controlled and operates on 10 channels. Sockets are provided for 20 crystals. Each channel can operate on two frequencies not more than one percent apart. Thus, the transmitter can be preset for operation on 20 frequencies. Output circuits tune automatically when a channel is selected at the remote control panel. Radio frequency power output is 80 to 100 watts into a 52-ohm line. Output is lowest between 16 and 18.5 mc.

The receiver is a crystal-controlled superheterodyne that operates on 10 channels. The number of preset frequencies can be increased to 20 by installing crystals for adjacent frequencies.

A dynamotor in the rear of the case provides plate and screen voltages for tubes in the radio frequency and modulator sections of the transmitter. Heater voltages are provided by connection to the 28-volt dc bus. The dynamotor operates only when the transmitter is keyed. Receiver tube voltages for plates, screens, and heaters are all supplied by the 28-volt dc bus.

6. Coupler Control

Provisions are made in the aft fuselage compartment for the installation of two Collins 309A-1 antenna coupler control units. Each coupler control operates with one 180R-4 antenna coupler assembly. The coupler control units are secured to shock-mounted bases by knurled nuts. Electrical connections are made through receptacles on the front panels.

These coupler controls, which are of modular construction, make most of the HF control circuits readily accessible for maintenance. The controls contain relay and switching circuits and servo amplifiers for the control of the 180R-4 antenna couplers.

7. Antenna Coupler Assembly

There are provisions for a antenna coupler assembly, 180R-4, which will contain the antenna loading and phasing elements and the associated driving motors for resonating the antenna and matching the impedance of the antenna to the 52-ohm impedance of the coaxial cable from the transmitter. The coupler tunes automatically over the frequency range of the transmitter-receiver. The antenna coupler connects to the HF antenna through a lightning arrestor. A maximum of about 20 seconds is required for resonating the antenna for maximum loading. A blower in the coupler unit cools the coupler.

An access door on the left-hand side of the fin permits access to the antenna coupler assembly for removal and installation.

8. Lightning Arrestor

The HF antenna coupler couples to the antenna through a Collins 452A-1 lightning arrestor relay unit. The lightning arrestor is mounted on the top of the unit. The relays in the unit prevent interaction between transmit and receive circuits and between the two HF systems.

The lightning arrestor, the relay unit, and the coupler assembly are installed together in the upper part of the vertical fin just below the fiberglas insulating shield.

9. Antenna

The fin tip of the vertical stabilizer consitutes the high frequency antenna for transmission and reception. This antenna is used by both No. 1 and No. 2 HF communications systems, when the HF systems are installed. The antenna coupler automatically tunes the HF antenna to the selected frequency of transmission.

A fiberglas shield insulates the HF antenna from the tail structure. The fiberglas is painted with special nonmetallic, nonconducting paint. Repairs to the finish of the HF antenna area must be made with suitable nonconducting paint.

10. Make-Up Air Supply

The 452A-1 relay assembly and 180R-4 antenna coupler assembly require a make-up air supply of approximately 24 cubic inches per hour. This air supply will maintain the relay and coupler assembly at an equivalent air pressure of from 0 to 7000 feet altitude. This air supply is provided through tubing from the aft cabin area pressure bulkhead to the coupler assembly installation in the vertical stabilizer. Normal operating range for the HF system is 0 to 50,000 feet altitude with a make-up air supply. If the air supply line should be plugged, or restricted in some other way, or if a large air leak should occur, an altitude switch in the coupler assembly will close to disable the transmitter.

HF CONTROL PANEL - MAINTENANCE PRACTICES

1. Removal/Installation HF Control Panel (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open HF COMM TX DC, REC DC, NO. 1 XCVR AC, NO. 1 TUNER AC, NO. 2 XCVR AC, NO. 2 TUNER AC, and SELCAL NO. 1 AC, NO. 1 DC, NO. 2 AC, NO. 2 DC circuit breakers. (Hang warning signs on open circuit breakers.)

      (2) Remove Selcal control panel and receptacle box assembly, (refer to Section 23-3-1, Removal/Installation).

   C. Remove HF Control Panel.

      (1) Release hex-head injector-extractor screw in center of panel.

      (2) Release four Camloc fasteners securing receptacle box to pedestal.

      (3) Move receptacle box up slightly and slide out HF control panel.

   D. Install HF Control Panel.

      (1) Slide HF control panel into receptacle box.

      (2) Position receptacle box over proper holes in pedestal, and fasten four Camloc fasteners.

      (3) Tighten hex-head injector-extractor screw in center of panel.

      (4) Install Selcal control panel and receptacle box assembly, (refer to Section 23-3-1, Removal/Installation).

      (5) Remove warning signs from circuit breakers listed in Step B. (1).

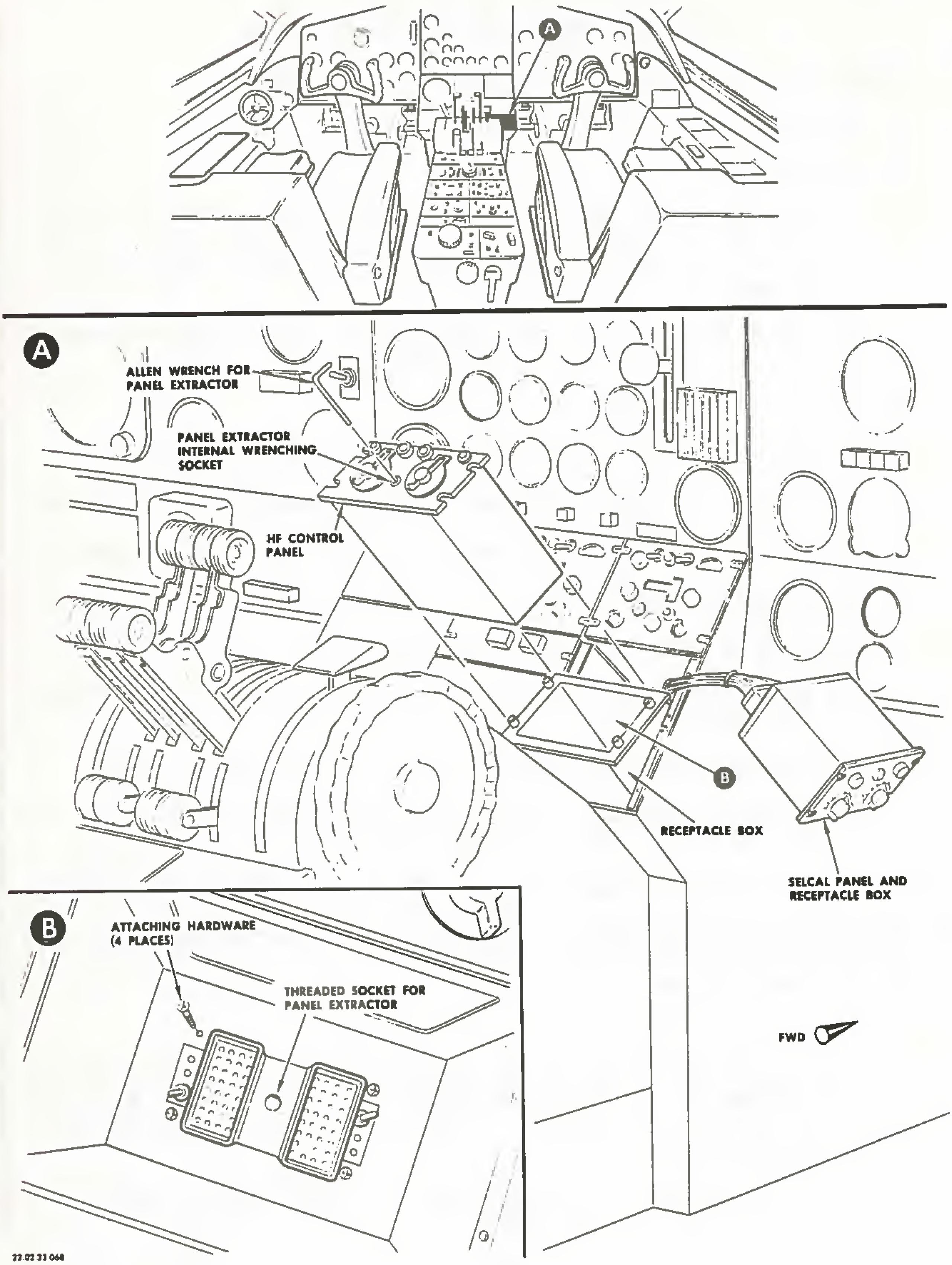
2. Removal/Installation HF Control Panel Receptacle Box (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open HF COMM TX DC, REC DC, NO. 1 XCVR AC, NO. 1 TUNER AC, NO. 2 XCVR AC, NO. 2 TUNER AC, and SELCAL NO. 1 AC, NO. 1 DC, NO. 2 AC, NO. 2 DC circuit breakers. (Hang warning signs on open circuit breakers.)

      (2) Remove Selcal control panel receptacle box, (refer to Section 23-3-2, Removal/Installation).



HF Control Panel Installation
Figure 201

C. Remove Control Panel Receptacle Box.

(1) Remove HF Control Panel as instructed in paragraph 1. C.

(2) Remove four screws and nuts which secure the receptacle to the box. Avoid dropping receptacle into control cables. Bag and tag screws and nuts for installation.

(3) Remove receptacle box.

D. Install Control Panel Receptacle Box.

(1) Slide receptacle box into position.

(2) Install receptacle in box and secure with four screws and nuts from Removal Step C. (1).

(3) Move receptacle box slightly forward and insert control panel.

(4) Secure control panel in receptacle box with hex-head injector-extractor screw in center of panel.

(5) Position receptacle box over proper holes and secure with Camloc fasteners.

(6) Install Selcal control panel and receptacle box assembly, (refer to Section 23-3-2, Removal/Installation).

(7) Remove warning signs from circuit breakers opened in Step B. (1).

VHF COMMUNICATIONS SYSTEM - DESCRIPTION AND OPERATION

1. General

Two VHF communications radio systems provide voice communication in 50-kc-spaced channels in the frequency range from 118.00 through 135.95 mc. Communication in the VHF band is limited to line of sight, and the range of communications is dependent on aircraft altitude. Average communicating distances from aircraft to ground stations are approximately 30 miles at 1000 feet and 135 miles at 10,000 feet.

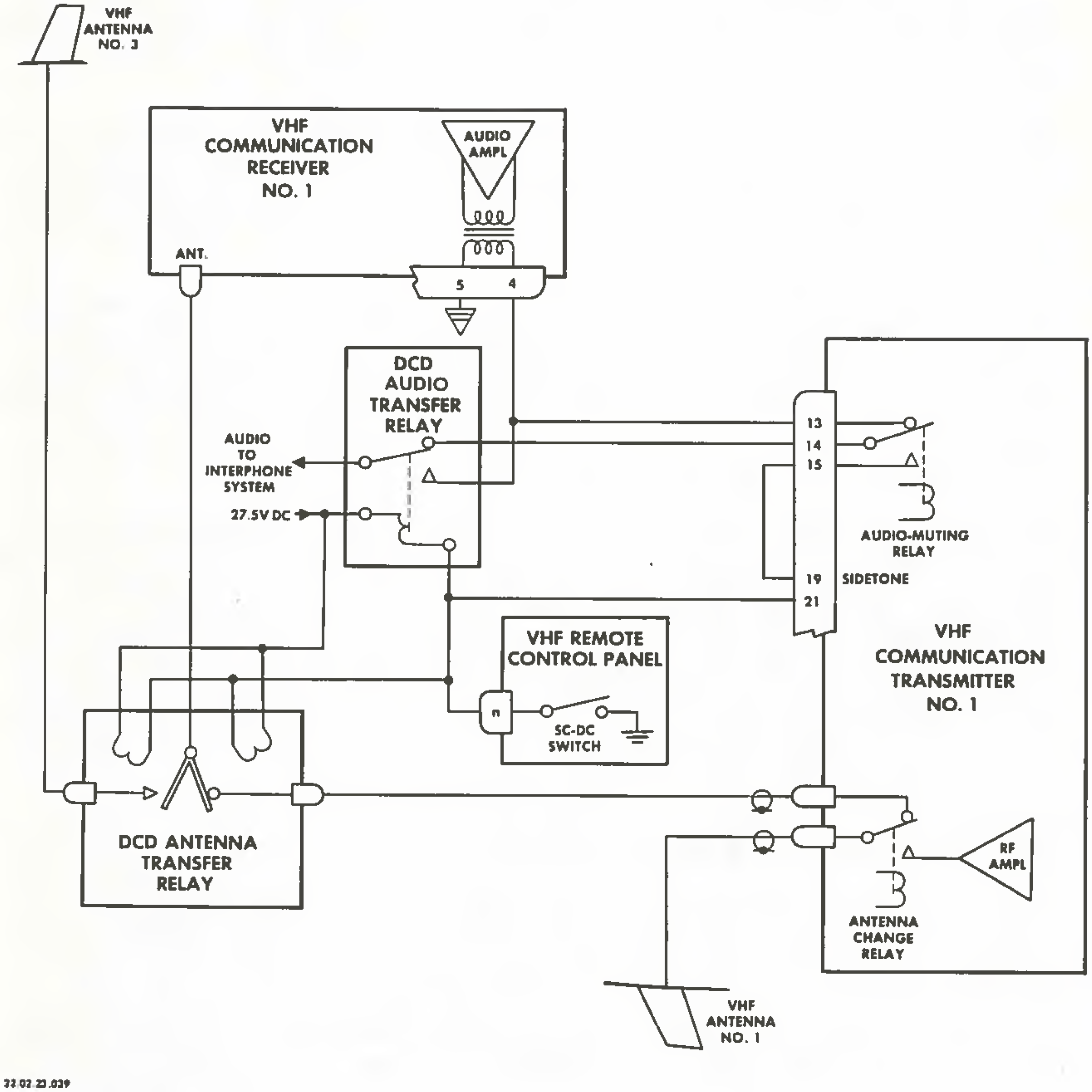
The VHF installations are designated VHF-1 and VHF-2 for selection of receiver and microphone audio. The operating frequency of either VHF system is selected at a remote control panel on the pilots' pedestal. VHF receiver and transmitter frequencies are simultaneously selected at the remote control panel.

Two modes of operation are possible: single-channel simplex (SCS) operation, in which the receiver and transmitter operate on the same frequency; and double-channel simplex (DCS) operation, in which the transmitter operates on a frequency six megacycles above the selected receiver frequency. Single- or double-channel selection is made at the remote control panel. Double-channel transmission is limited to the frequency range from 124.00 through 126.95 mc and 133.00 through 135.95 mc.

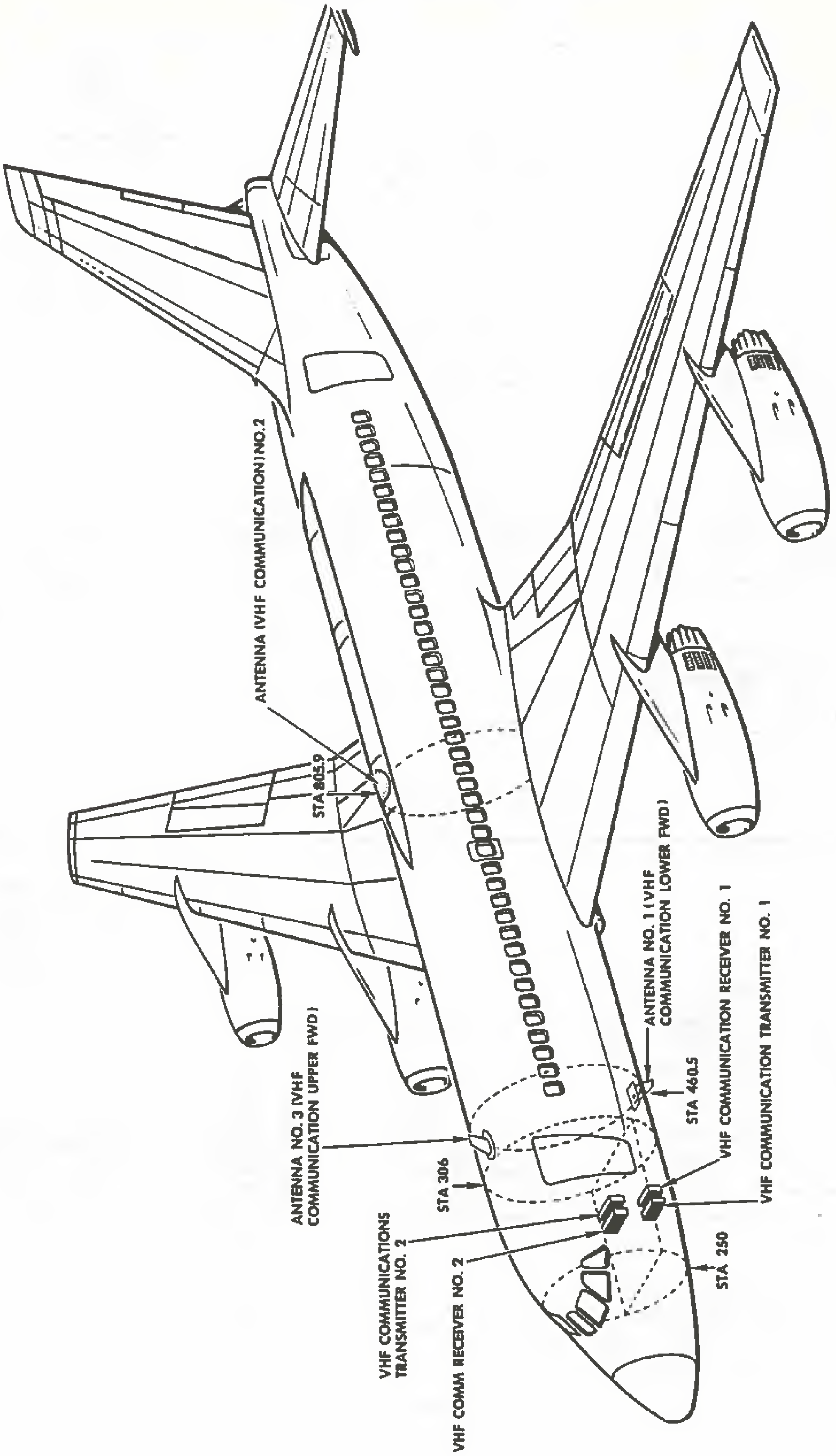
Provisions are made to operate the No. 1 VHF system in a third mode called double-channel duplex (DCD). In this mode the transmitter operates as in the DCS mode, but does not mute receiver audio or transfer antenna circuits. Two radio rack mounted relays, energized through the SCS-DCD switch, connect the VHF communications No. 3 antenna to the receiver and route receiver audio directly to the flight interphone system. This relay action permits simultaneous operation of the transmitter and receiver on different frequencies. DCD operation may be used by the Air Traffic Control Signaling System (ATCSS) at a later date when this system becomes operational. See Figure 1 for an illustration of DCD relay circuitry.

2. VHF Communications Equipment and Location

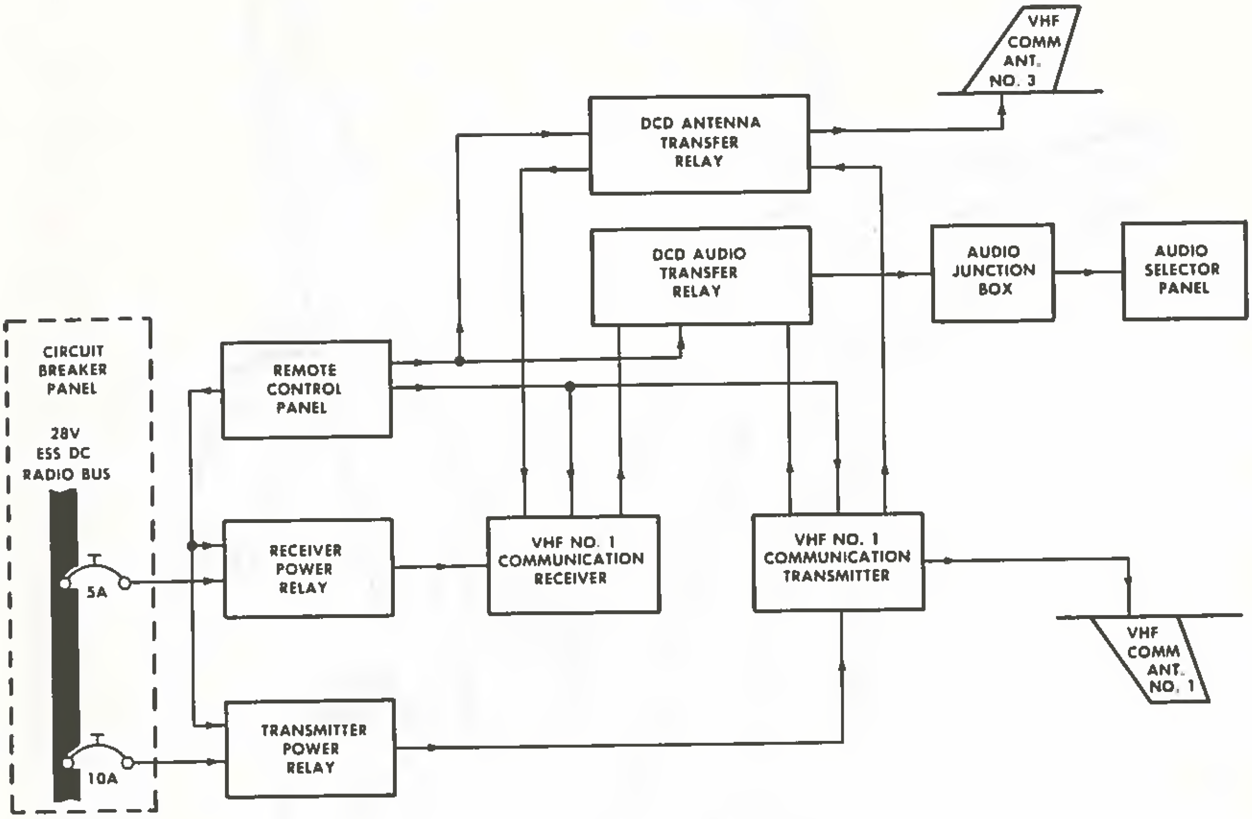
Each of the two VHF communications systems consist of Collins 51X-2 receiver, a Collins 17L-7 transmitter, a remote control panel, two power relays and an antenna. The VHF-1 communications system is provided with an added antenna transfer relay and audio transfer relay for DCD operation. The VHF communications No. 3 antenna required for DCD operation is installed on the upper fuselage centerline. The receivers, transmitters and power relays are installed in the electronics compartment. The remote control panels are installed in the pilots' pedestal. The flush mounted VHF communications No. 2 antenna is installed on the upper fuselage centerline and the blade-type VHF communications No. 1 antenna is mounted on the lower fuselage centerline. Figure 2 shows the location of the VHF equipment. Figure 3 shows a block diagram of both VHF communications systems. Figure 4 shows the location of VHF power relays and DCD antenna and audio transfer relays.



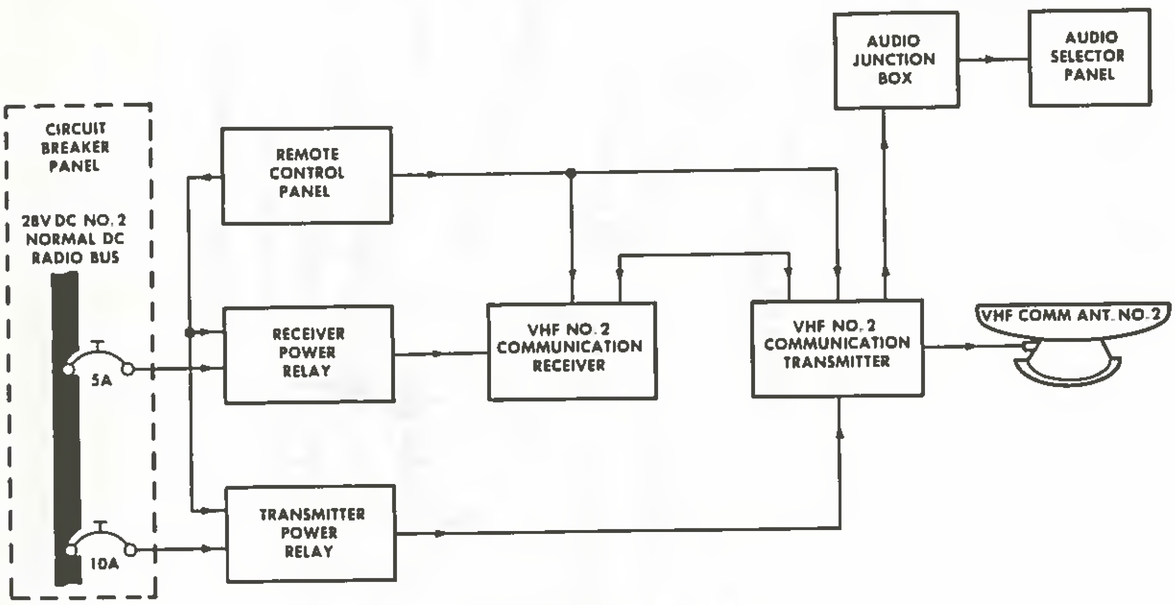
No. 1 VHF System DCD Transfer Relays
Figure 1



VHF Communications System, Location Diagram
Figure 2



NO. 1 VHF RECEIVER AND TRANSMITTER



NO. 2 VHF COMMUNICATIONS SYSTEM

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VHF Communications Systems, Block Diagram
Figure 3

3. Power Requirements

The Collins 17L-7 transmitter requires 180 watts of primary power under key down conditions. The Collins 51X-2 receiver requires 90 watts of primary power while channeling and 33 watts for normal reception. The No. 1 VHF communications system draws power from the 28-volt essential dc radio bus. The No. 2 VHF Communications system draws power from the 28-volt No. 2 normal dc radio bus which is energized by the essential dc bus through the No. 2 normal bus relay.

4. Circuit Protection

Each transmitter power circuit is protected by a 10-ampere circuit breaker. Each receiver circuit is protected by a 5-ampere circuit breaker. The circuit breakers are located on the main circuit breaker panel.

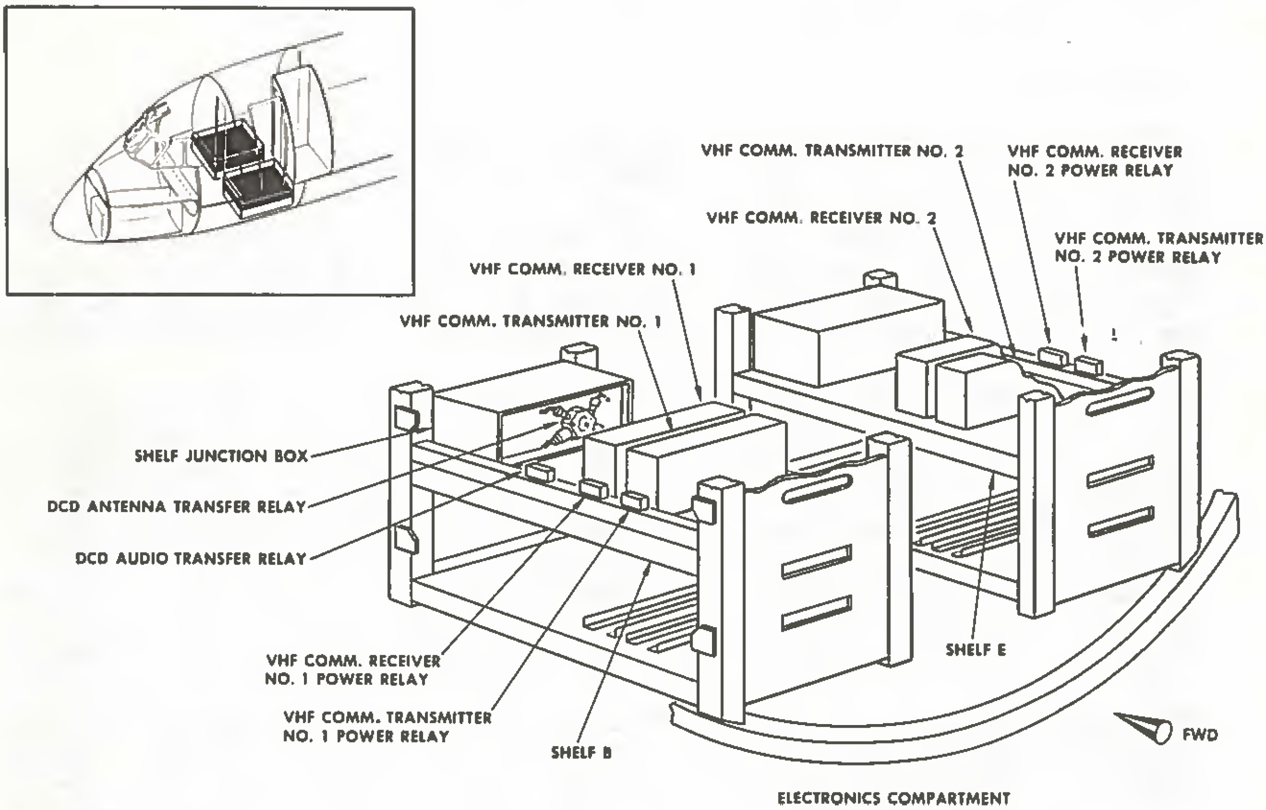
5. Control Panel

An Electronic-Equipment Engineering (E.E.E.) type 261 control panel combines the controls for a VHF communications system and a VHF navigation system into a single panel. A white line through the center of the panel separates the two functions. Two control panels are installed on the pilots' pedestal. The left panel controls the No. 1 VHF communications and navigation system; the right panel controls the No. 2 VHF communications and navigation system. See Figure 5 for an illustration of the VHF control panels.

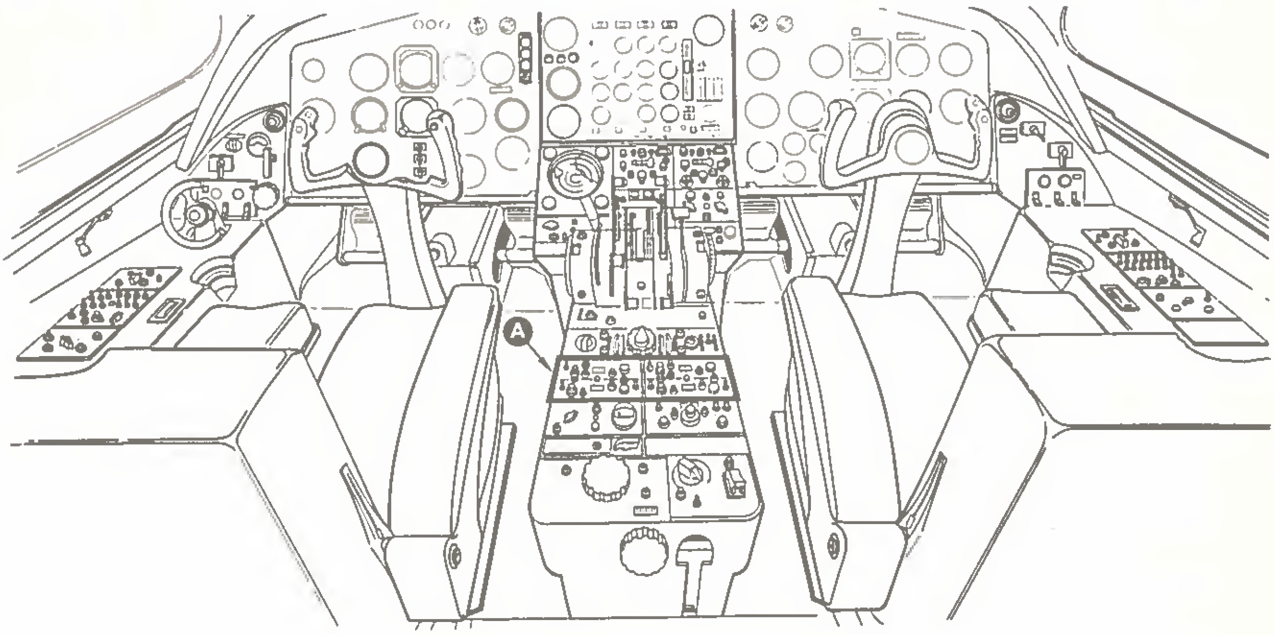
The white knobs on the upper half of the panel control the VHF communications system. The knob on the left side of the panel controls frequency selection in one megacycle steps in the frequency range from 118 to 135 mc. The knob on the right side of the panel controls frequency selection in .05 mc steps. Selected frequencies appear in the window marked VHF. The smaller knob mounted on top of the one megacycle selector knob is the VHF Communications system ON/OFF switch and receiver sensitivity control. With the knob in the full counterclockwise position the receiver sensitivity is minimum; in the full clockwise position the receiver sensitivity is maximum.

The toggle switch in the upper left corner selects double-channel (DC) or single-channel (SC) mode of operation. When the switch is placed in the DC position (control wire grounded) autopositioners in the transmitter tune it to a frequency 6 mc higher than the frequency shown in the control panel frequency window. Double-channel transmission is limited to the frequencies from 124.00 through 126.95 mc and 133.00 through 135.95 mc. These frequencies are selected when the VHF control panel reads from 118.00 through 120.95 mc and from 127.00 through 129.95 mc.

To prevent transmission on unauthorized frequencies the SC/DC control switch is wired to the transmitter through the control panel frequency selector switch in such a way that continuity of the DC control wire is broken for all frequency selections except 118.00 through 120.95 and 127.00 through 129.95 mc.



VHF Communications System, Location of Power
and DCD Transfer Relays
Figure 4



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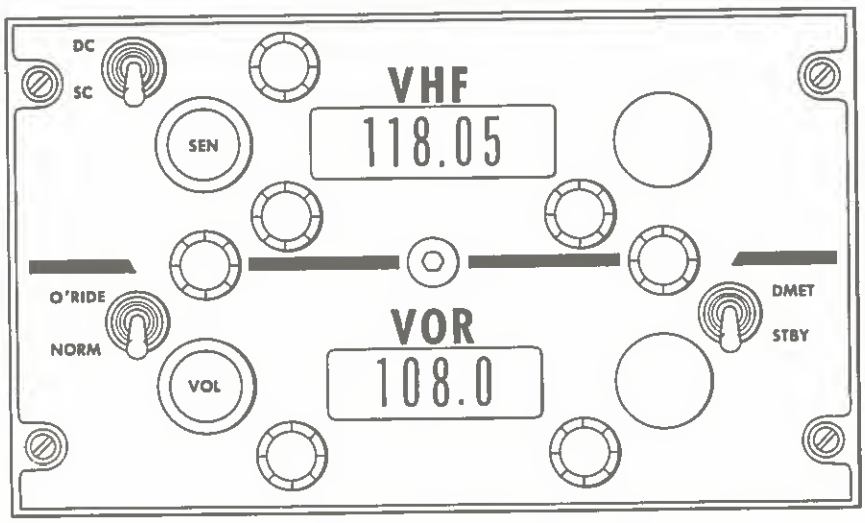


(TYPICAL 2 PLACES)

22 02 23 080

VHF Communications System Control Panel
Figure 5

6. Receiver

The Collins 51X-2 receiver is a crystal-controlled, double-conversion superheterodyne receiver capable of receiving amplitude modulated signals on 880 channels in the frequency range from 108.00 through 151.95 mc. The full frequency range is not utilized in the present installation. The G-510V control panel channels the receiver from 118.00 through 135.95 mc.

The 51X-2 receiver complies with specifications in ARINC Characteristic Report No. 520-A. It is housed in a short 3/8 ATR case and weighs 10.5 pounds. It employs 9 tubes, 1 transistor and 7 crystal diodes. All electrical connections to the rack including the antenna are made through a connector in the rear of the receiver case.

The receiver front panel contains a headset jack for local monitoring of receiver audio, a potentiometer to control squelch threshold and a push button to disable the squelch circuit.

7. Transmitter

The Collins 17L-7 Transmitter is a crystal-controlled transmitter capable of transmitting a 25-watt amplitude-modulated carrier on 680 channels separated by 50 kc in the frequency range from 118.00 to 151.95 mc. The frequency range is divided in two bands; high band; 136.00 to 151.95 mc and low band; 118.00 to 135.95 mc. The transmitter's full frequency range is not utilized in the present installation. The G-510V control panel channels the transmitter from 118.00 through 135.95 mc.

The 17L-7 transmitter complies with the specification in ARINC Characteristic Report No. 520-A except that it is housed in a short 3/8 ATR case and has antenna connections in the rear of the case. Two Cannon DPA-type connectors in the rear of case provide all electrical connections to the transmitter.

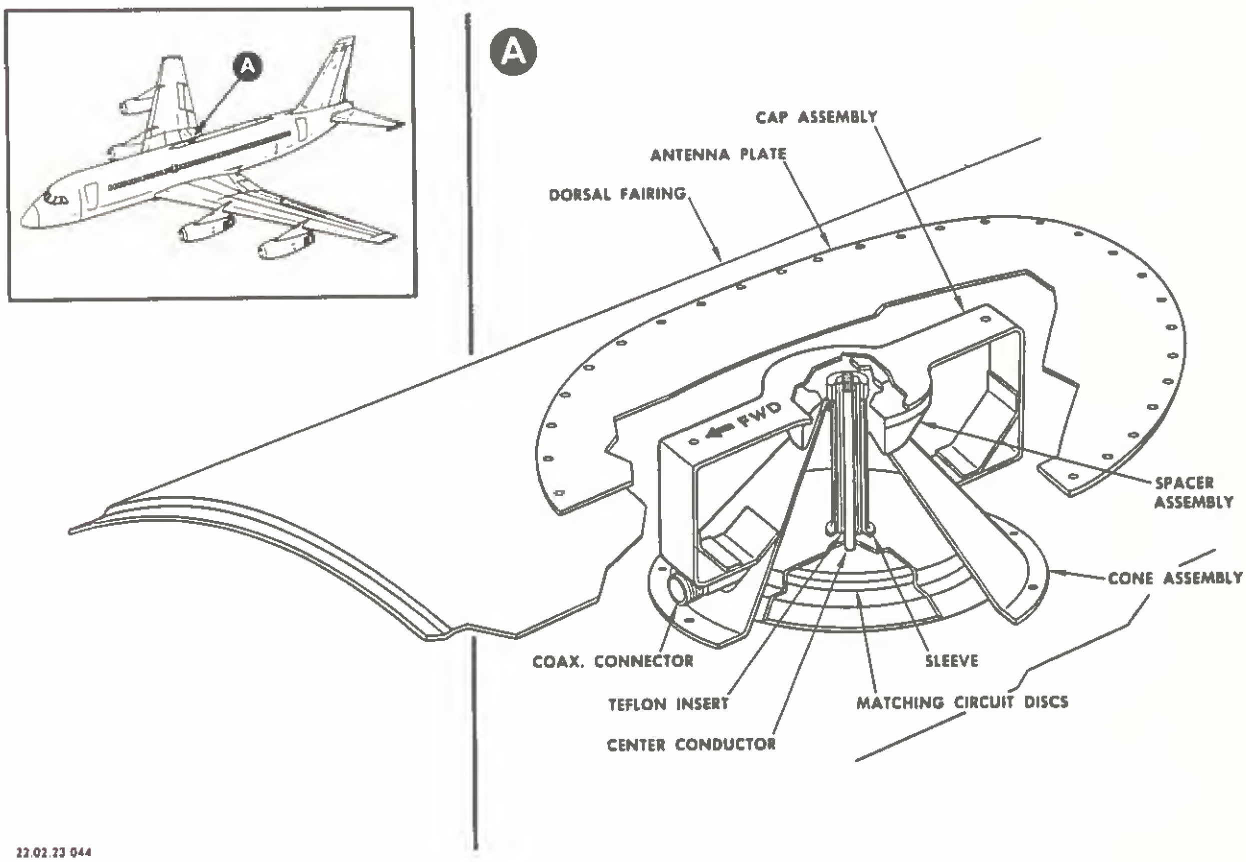
The transmitter front panel contains a microphone jack for local keying of the transmitter, a circuit selector switch and meter to measure internal operating voltages, frequency index windows through which the operating frequency may be read, and an extended range indicator lamp that lights when the transmitter is operating in the high band frequency range of 136.00 to 151.95 mc.

8. VHF Communications Antenna No. 1

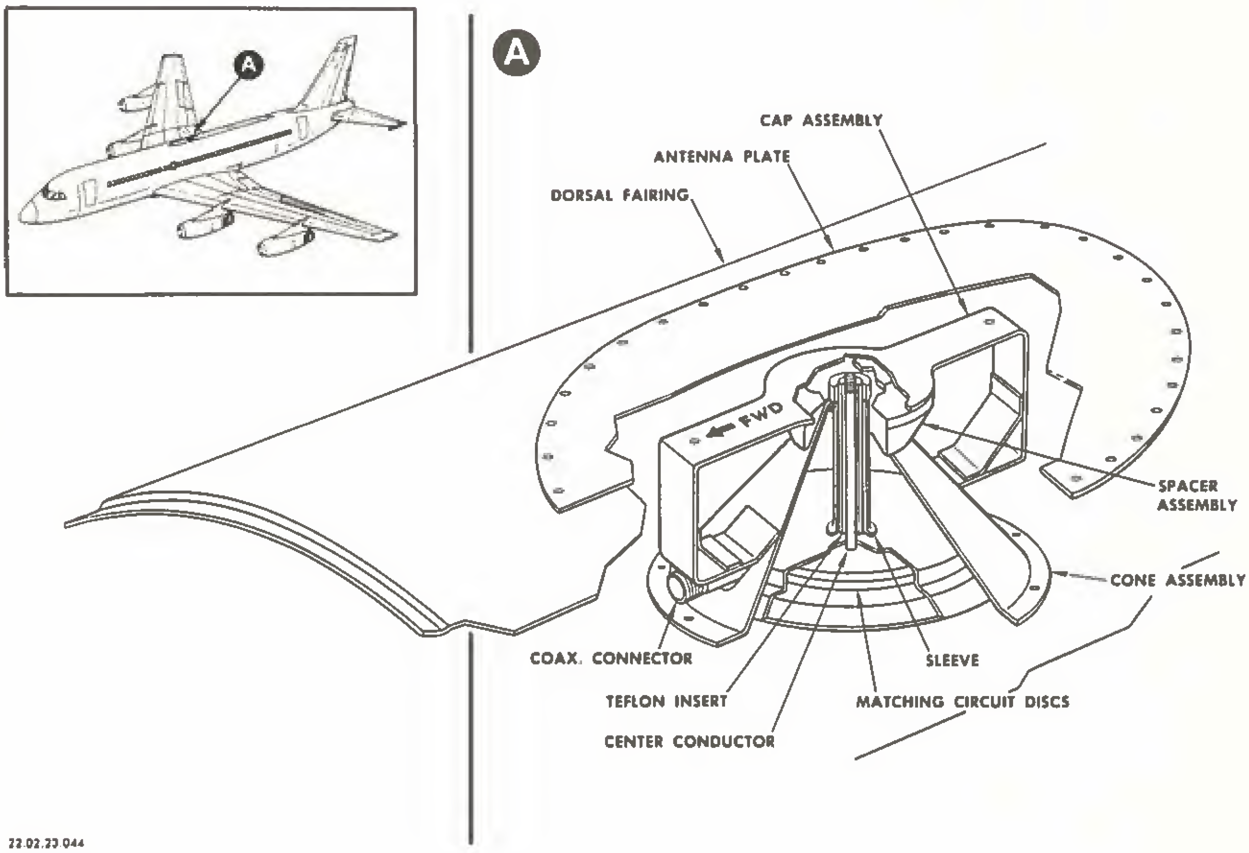
The VHF communications antenna No. 1 and No. 3 are enclosed in a fairing that is sharply swept back for aerodynamic streamlining. The antenna receives and transmits vertically polarized radio waves over the VHF range from 118 to 136 mc. The No. 1 antenna is located on the lower fuselage centerline at station 460. The No. 3 antenna is located on the upper fuselage centerline at station 384.

9. VHF Communications Antenna No. 2

The VHF communications antenna No. 2 has zero aerodynamic drag in flight. It is flush mounted in the forward section of the dorsal fairing at station 805.9. See Figure 6.



VHF Communications System Antenna No. 2
Figure 6



VHF Communications System Antenna No. 2
Figure 5

VHF COMMUNICATIONS SYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. WEAK OR NO OUTPUT FROM THE TRANSMITTER, NO SIDE TONE	
A. Defective transmitter.	Check front panel meter readings (refer to Adjustment/Test section for typical meter readings). Replace the transmitter if readings are not as specified. Check system operation.
2. WEAK OR INTERMITTENT TRANSMISSION SIDETONE OK, METER READINGS OK	
A. Defective antenna.	Use rf wattmeter to measure the percentage of reflected power from the antenna. (Refer to Adjustment/Test section for instructions on the use of the rf wattmeter). If reflected power is greater than 15 percent throughout the transmitter frequency range, replace the antenna. Check system operation.
B. Defective coaxial cable transmission line.	Disconnect the coaxial cable connector from the VHF antenna. Measure the coaxial dielectric leakage resistance with a Megger. If leakage resistance is less than 10 megohms, replace the coaxial cable. Check coaxial connectors, be sure that leakage is not due to foreign matter in the plugs or to carbonization of the dielectric material in the plug.
3. TRANSMITTER NOT CHANNELING TO THE SELECTED FREQUENCIES	
A. The control panel SC-DC switch was inadvertently placed in the DC position or the SC-DC control wire is grounded in the junction box.	Check the frequency appearing in the transmitter frequency index window. If it is 6 mc higher than the receiver frequency, check the position of the SC-DC switch on the control panel. Check for grounded control wire. If wire is grounded, repair or replace.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
B. Defective remote control panel or defective channel control wiring.	Interchange No. 1 and No. 2 remote control panels. If channeling is now correct in the faulty system and incorrect in the other system, replace the suspected control panel. If incorrect channeling is still evident in the faulty system check channel control wiring per system wiring diagram. Check the VHF system after repair or replacement of the wiring or control panel.
C. Defective transmitter.	Note the incorrect frequency appearing in the suspected transmitter frequency index window, then interchange No. 1 and No. 2 VHF transmitters. If the correct frequency now appears in the window of the alternate system transmitter replace the suspected transmitter. Check system operation.

4. LOW TRANSMITTER SIDETONE LEVEL

A. Defective transmitter.	Check the front panel meter readings. If the rf output (ANT) or modulation voltage (MOD-E) is low replace the transmitter. Check system operation. Adjust sidetone level only if replacement transmitter is not available

5. WEAK OR NO AUDIO OUTPUT FROM THE RECEIVER

A. Defective receiver	Interchange No. 1 and No. 2 VHF receivers. If audio is now available in the faulty system but not in the other, replace the suspected receiver. Check system operation.
B. Defective receiver audio muting relay in the system transmitter.	Interchange No. 1 and No. 2 transmitters. If audio is now available in the faulty system but not in the other, replace the suspected transmitter. Check system operation.
C. Defective double-channel audio or antenna transfer relays in the VHF No. 1 system.	These relays are not presently activated but audio and antenna currents pass through their normally closed contacts. Tap relays while listening to receiver audio. Replace relays suspected of making poor contact. Check system operation.

	POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
D.	Defective antenna.	Check antenna efficiency with transmitter power as described in paragraph 2.A.
E.	Defective coaxial transmission cable.	Check coaxial cable leakage resistance as described in paragraph 2. B.

6. RECEIVER NOT CHANNELING TO SELECTED FREQUENCIES

	POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
A.	Defective receiver.	Use procedure described in paragraph 3. C.
B.	Defective remote control panel or defective channel control wiring.	Use procedure described in paragraph 3. B.

VHF COMMUNICATIONS SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test VHF Communications System

   A. General.

      Use the following test procedure as a routine or preflight operational check of the VHF system. Perform the tests in an area free of other airplanes and equipment and not adjacent to buildings.

   B. Equipment Required.

      (1) External power unit.

      (2) RF wattmeter, Bird thruline Model 43, with 10 and 50 watt elements covering the frequency range of 100 to 250 mc.

   C. Preparation.

      (1) Connect the external ac power unit and switch on electrical power.

      (2) Close the following circuit breakers:

         (a) VHF XMTR NO. 1 DC & AC, RCVR NO. 1 DC & AC, XMTR NO. 2 DC & AC, RCVR NO. 2 DC & AC.

         (b) AUDIO SELECT - PILOT & RADIO RACK DC, COPILOT & FLT. ENGR. DC.

         (c) ELECT COMPT FAN CONT.

      (3) Switch on ESSENTIAL and NORMAL electric power on the radio power panel in the overhead switch panel.

      (4) Close the ELEC COMPT COOL FAN switch in the air-conditioning section of the flight engineer's panel. Make sure that the LOW AIR FLOW warning light to the left of this switch is not illuminated.

   D. Test VHF Receiver.

      (1) Turn the VOL knob on both VHF COMM control panels to the full clockwise position. Allow sufficient time for the receivers to warm up. Receiver squelch should be set to quiet all background noise. Set receiver audio to a comfortable level with the VOL knob on the audio selector panel.

      (2) Select an active local channel for both receivers. Listen to communications traffic and compare receiver sensitivities. Both receiver squelch circuits should open on the same signal and audio levels should be approximately the same. Note that strong signals do not block the receiver or cause distortion of receiver audio.

(3) Reduce audio volume while listening to communications. Control of audio level should be smooth and continuous throughout range of control.

(4) Check receiver channeling accuracy on a number of channels. Frequencies selected at the remote control panel should appear in the frequency index window on the receiver front panel.

(5) Plug a headset into the receiver front panel jack and press the front panel squelch button. The receiver squelch circuit should open, and background noise and communications traffic, if present, should be heard.

E. Test VHF Transmitter.

NOTE: Before making voice transmissions or RF power output checks, listen to the channel to which the transmitter is tuned. Be sure that the channel is clear before keying the transmitter.

(1) Place the SC-DC switch on the remote control panel in the SC position.

(2) Check transmitter channeling accuracy on a number of channels in the communications frequency range. Frequencies selected at the remote control panel should appear in the frequency index window on the transmitter front panel. During the tune cycle listen to the operation of the gears in the autopositioner gear box. The operation should be smooth and unlabored. The tune cycle should be completed within four seconds.

(3) Connect a microphone and a headset into the electronic compartment jackbox, and select the VHF system headset and microphone audio at the radio rack audio selector panel.

(4) Key the transmitter and check the meter indications for all positions of the front panel circuit meter switch. Compare these readings with the chart shown below.

CIRCUIT METER POSITION	TYPICAL INDICATIONS	
ANT	0.6	
PA-G	0.4 to 1.0	
DR-G	0.3 to 0.6	
MOD-E	0.45*	
BAT	0.7	
LV	0.7	
HV	0.7	*with voice
PA-P	0.7	modulation

Any significant variation from the typical readings indicates defective circuitry or improper tuning of the transmitter. In the MOD-E (modulation voltage) switch position, modulate the transmitter with a strong voice. Meter readings should not be greater than 0.45 on modulation peaks. Sidetone audio should be loud and clear while voice-modulating the transmitter.

(5) Make an operational ground check of the VHF system on a local tower or ground control frequency. Enter the report on the aircraft maintenance log.

(6) Place the SC-DC switch on the remote control panel in the DC position. Select several frequencies in the 118.00 to 120.95 mc and 127.00 to 129.95 mc frequency range. As each frequency is selected at the remote control panel a number 6 mc higher than in the control panel window should appear in the frequency window on the transmitter front panel. Safety-wire the SC-DC switch to the SC position when the check is complete.

2. Adjustment/Test VHF Communications Antenna (see Figures 201 and 202)

A. General.

The following test procedure measures the transmitter power to the VHF antenna and the power reflected by the antenna. The difference between these two is a measure of antenna efficiency. An antenna damaged by lightning strike or moisture is inefficient, reflects a large part of the transmitter power, and reduces the ranges of transmitter and receiver.

B. Preparation.

(1) Connect the wattmeter in series with the antenna as shown in Figure 201 by a short length of coaxial cable with fittings.

(2) Insert the 50 watt element in the wattmeter with the arrow pointed in the direction of the antenna. See Figure 202, Detail A.

NOTE: Monitor the frequency before keying the transmitter.

C. Test VHF Antenna.

(1) Key the transmitter and note the forward power (Wf) reading.

(2) Remove the 50-watt element and insert the 10-watt element with the arrow pointed away from the antenna. See Figure 202, Detail B. The ten watt element provides greater sensitivity. Be sure that it is inserted with the arrow pointed away from the antenna, otherwise the wattmeter may be damaged.

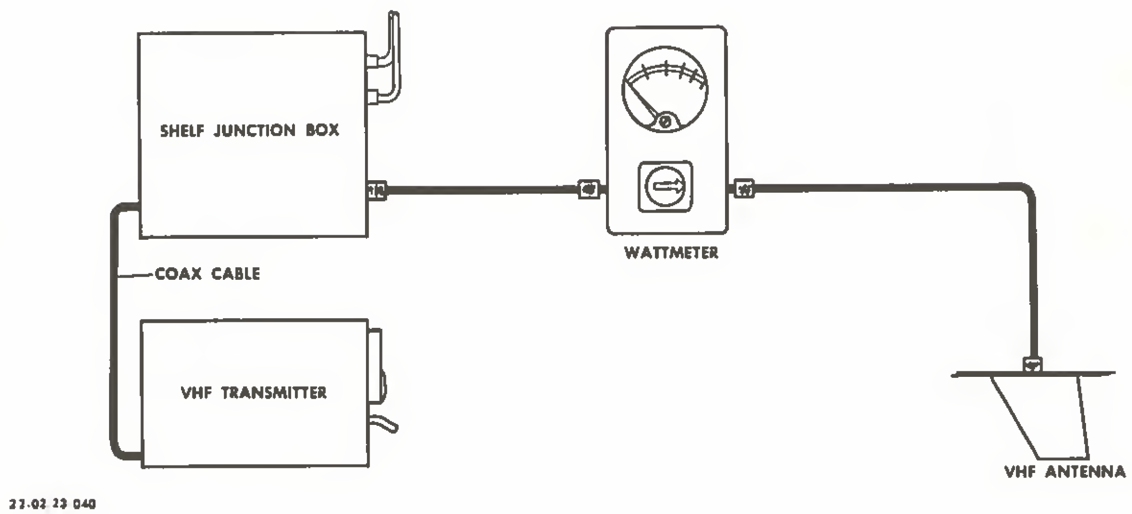
(3) Key the transmitter and note the reflected power (Wr) reading.

(4) Calculate Ø, the percentage of reflected power to transmitted power, with the following equation:

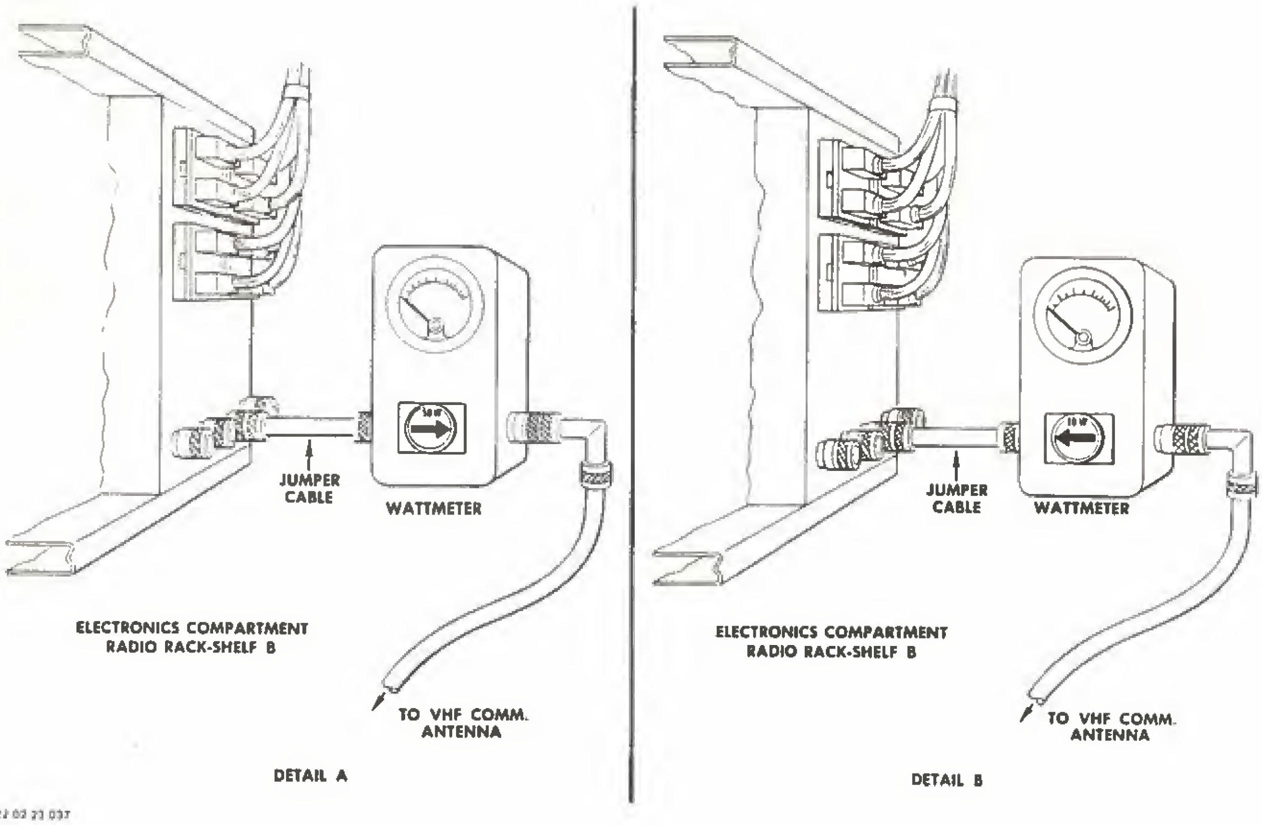
$$\emptyset = \frac{Wr}{Wf} \times 100$$

Reflected power percentage greater than 15 (VSWR worse than 2:1) indicates poor antenna efficiency and the antenna should be replaced.

(5) Remove test equipment and restore airplane equipment to original configuration.



VHF Communication System Transmitter -
RF Wattmeter Connection
Figure 201



VHF Antenna - Percent Reflected
Power Test
Figure 202

VHF CONTROL PANEL - MAINTENANCE PRACTICES

1. Removal/Installation VHF Control Panel (see Figure 201)

   A. Equipment Required - None.

   B. Preparation. Open VHF COMM RCVR/XMTR, VHF NAV and PED & OVBD PNL LTS circuit breakers located on the main circuit breaker panel. (Hang warning signs on opened circuit breaker.)

   C. Remove VHF Control Panel.

      (1) Turn the Allen-head injector-extractor screw on the front face of the control panel in the counterclockwise direction until the panel plug disengages the pedestal receptacle.

      (2) Remove the panel from the pedestal.

      (3) Apply masking tape to the control panel plug and pedestal receptacle to prevent the entry of foreign material.

   D. Install VHF Control Panel.

      (1) Remove the protective masking tape from the control panel plug and pedestal receptacle.

      (2) Insert the panel into the pedestal opening, engage index pins and press the panel down.

      (3) Turn the Allen-head injector-extractor screw clockwise until screw torque indicates that the panel plug has fully engaged the pedestal receptacle.

      (4) Remove warning signs and close the VHF COMM RCVR/XMTR, VHF NAV and PED & OVHD PNL LTS circuit breakers.

      (5) Test system operation, (refer to Section 23-2-0, Adjustment/test).

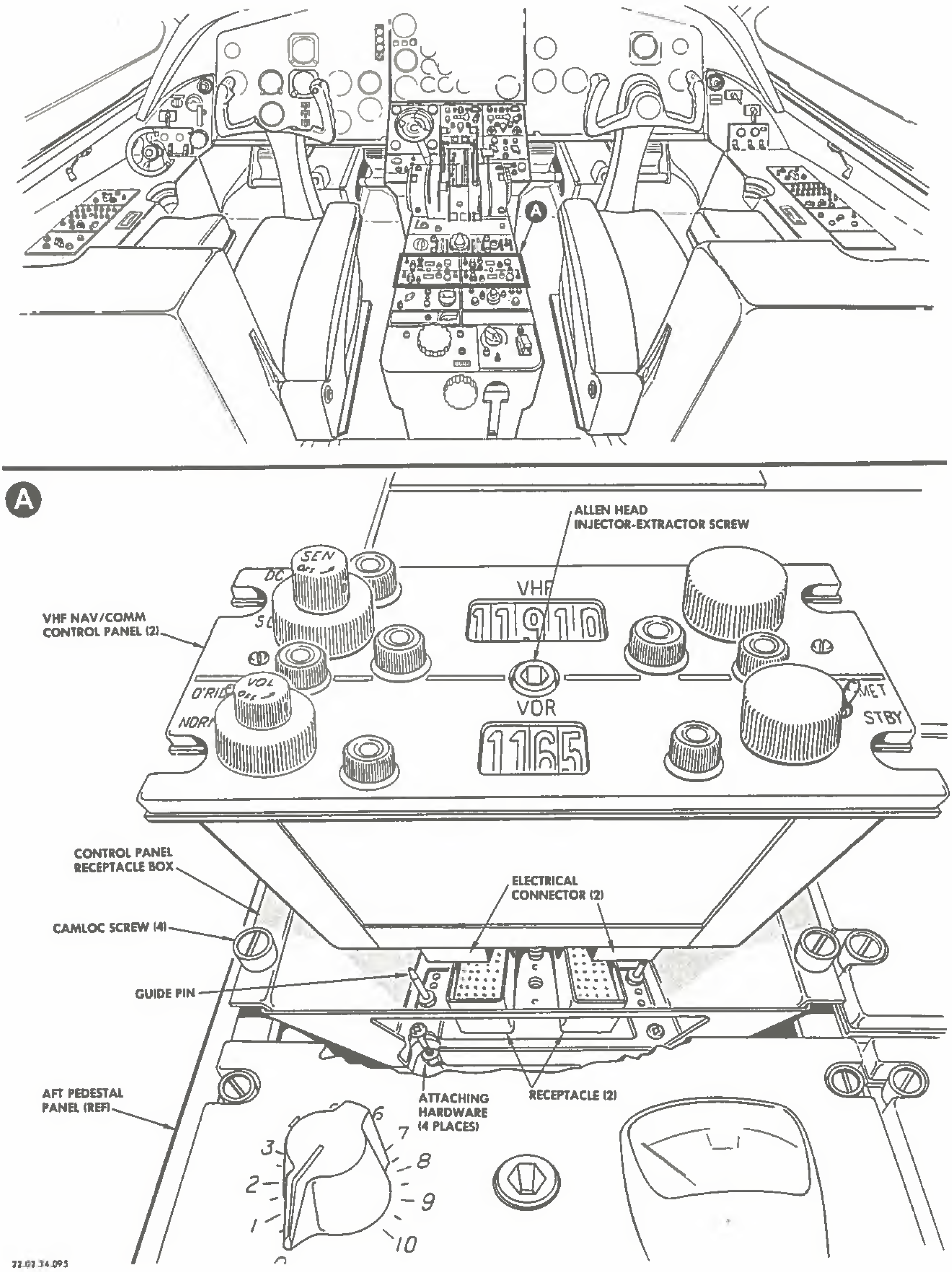
2. Removal/Installation VHF Control Panel Receptacle Box (see Figure 201)

   A. Equipment Required - None.

   B. Preparation. Open VHF COMM RCVR/XMTR, VHF NAV and PED & OVHD PNL LTS circuit breakers. Hang warning signs on opened circuit breakers.

   C. Remove Control Panel Receptacle Box.

      (1) Remove the VHF control panel, follow instructions given in paragraph 1.C.



VHF Communications System Control
Panel Installation
Figure 201

(2) Remove the pedestal side cover plates to gain access to the back of the receptacle box.

(3) Remove the four screws that secure the receptacle to the box. (Bag and tag for installation.)

(4) Remove the receptacle from the box. Tie back the receptacle cable to prevent it from dropping into the control cables below.

(5) Release the four Camloc fasteners that secure the box to the pedestal frame.

(6) Remove the receptacle box from the pedestal.

(7) Replace the pedestal side cover plates.

D. Install the Control Panel Receptacle Box.

(1) Insert the receptacle box into the pedestal opening.

(2) Secure the four Camloc fasteners to the pedestal frame.

(3) Remove the pedestal side cover plates.

(4) Remove ties placed there to prevent the receptacle cable from dropping into the control cables.

(5) Secure the receptacle to the box with the hardware provided.

(6) Replace the pedestal side cover plates.

(7) Replace the VHF control panel. Follow instructions given in paragraph 1.D.

(8) Close VHF COMM RCVR/XMTR, VHF NAV and PED & OVHD PNL LTS circuit breakers and remove warning signs.

(9) Test system operation, (refer to Section 23-2-0, Adjustment/Test).

VHF RECEIVER - MAINTENANCE PRACTICES

1. Removal/Installation VHF Receiver (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open the VHF COMM RCVR circuit breaker. Hang warning sign on open circuit breaker.

   C. Remove VHF Receiver.

      (1) Locate the receiver in the electronics compartment radio rack.

      (2) Loosen the knurled nuts to disengage the hold-down clamps that secure the receiver to the rack.

      (3) Pull the receiver from the rack.

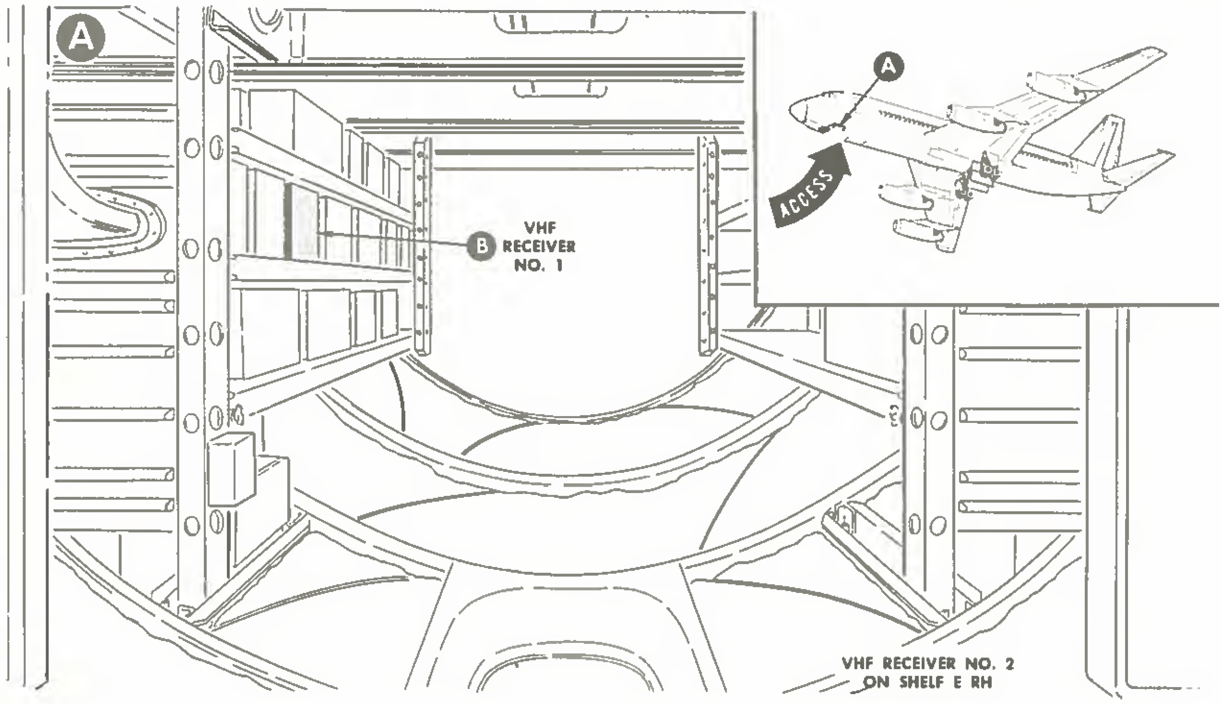
   D. Install VHF Receiver.

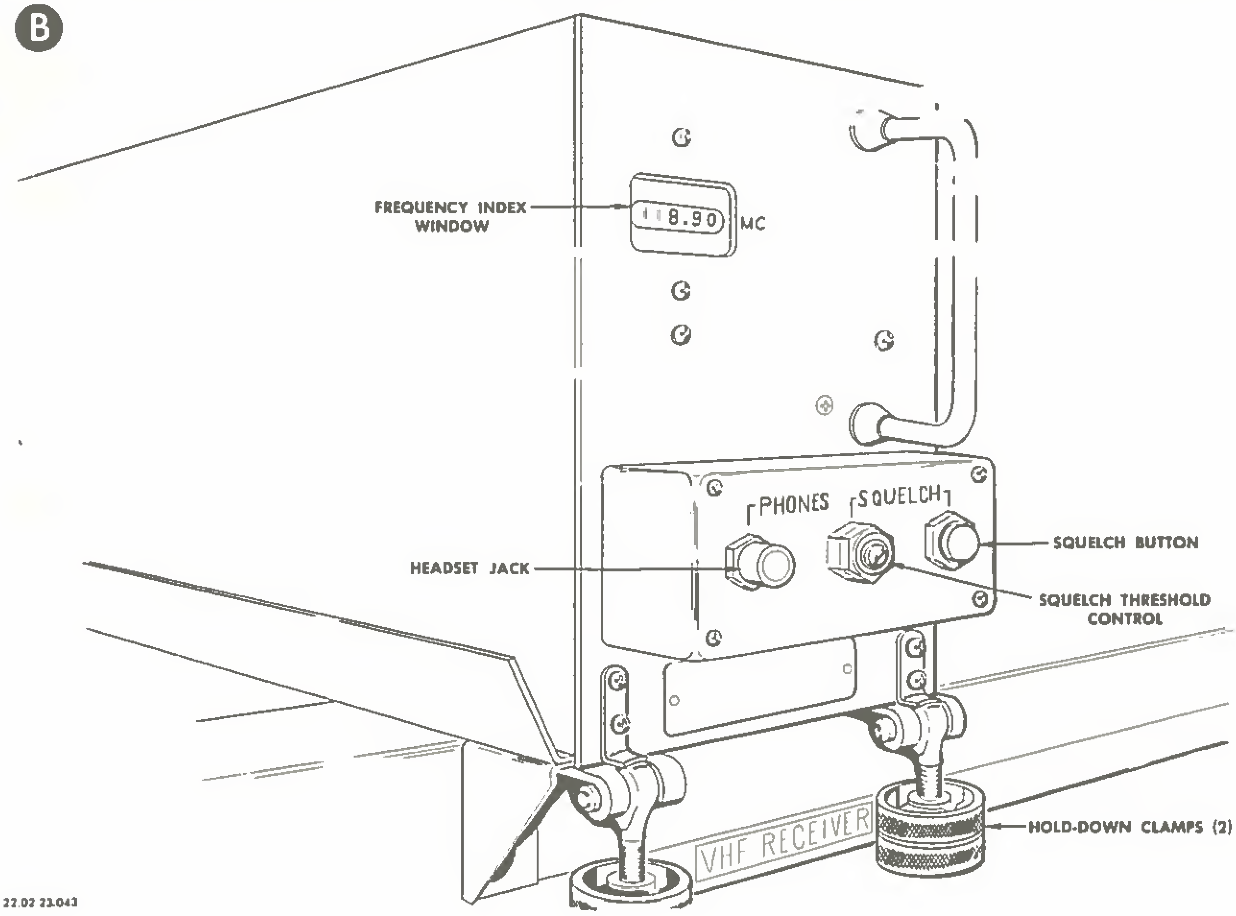
      (1) Place the receiver in the rack slides and push toward the rear so that the rear connectors are fully engaged.

      (2) Engage the hold-down clamps and tighten the knurled nuts to secure the receiver to the rack.

      (3) Close the VHF COMM RCVR circuit breaker and remove the warning sign.

      (4) Test system operation (refer to Section 23-2-0, Adjustment/Test).





VHF Communications Receiver Installation
Figure 201

VHF TRANSMITTER - MAINTENANCE PRACTICES

1. Removal/Installation VHF Transmitter (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open the VHF COMM XMTR circuit breaker. Hang warning sign on open circuit breaker.

   C. Remove VHF Transmitter.

      (1) Locate the transmitter in the electronics compartment radio rack.

      (2) Loosen the knurled nuts to disengage the hold-down clamps that secure the transmitter to the rack.

      (3) Pull the transmitter from the rack.

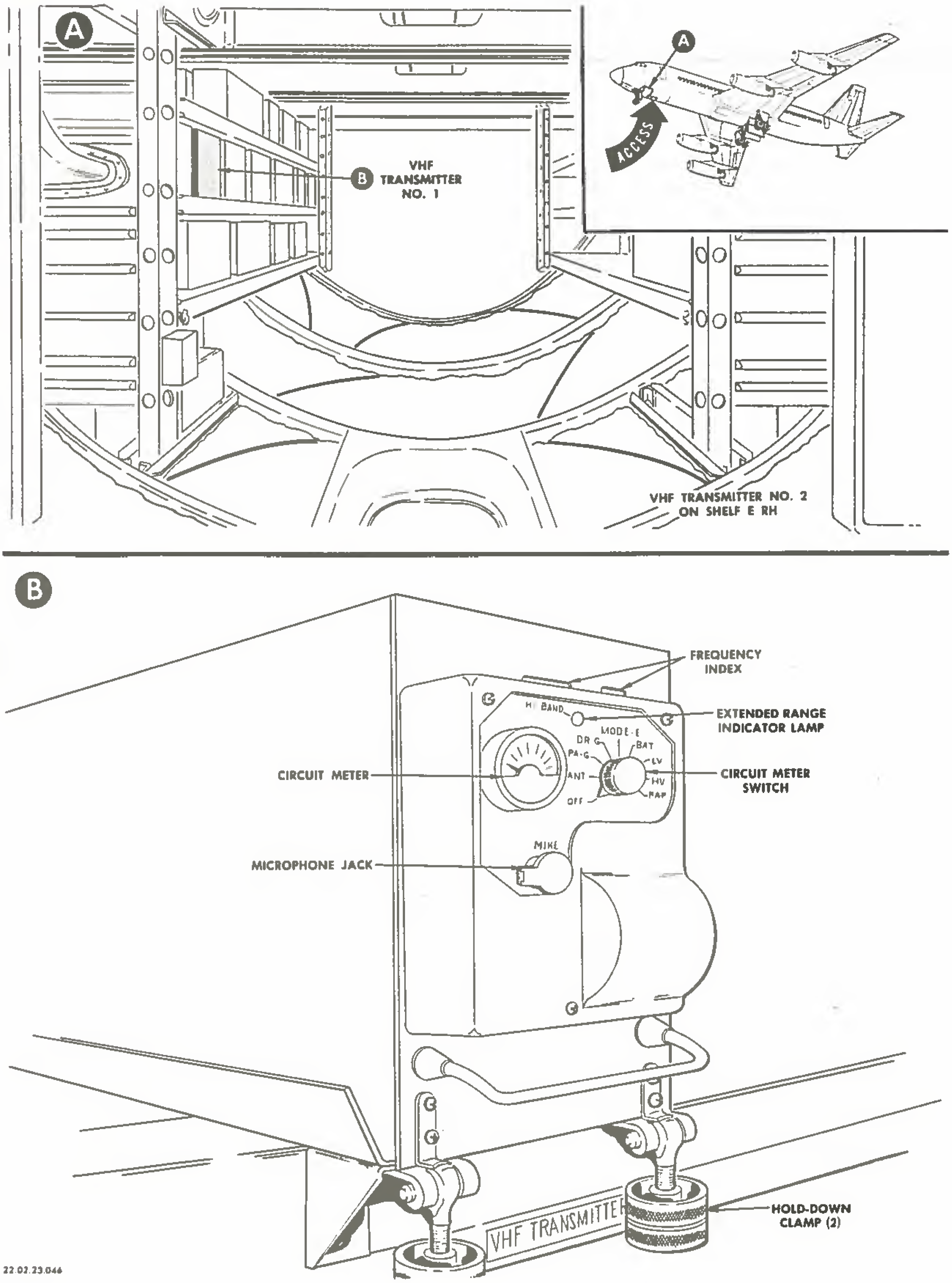
   D. Install the transmitter.

      (1) Place the transmitter in the rack slides and push toward the rear until rear connectors are fully engaged.

      (2) Engage the hold-down clamps and tighten the knurled nuts to secure the transmitter to the rack.

      (3) Remove the warning sign and close the VHF COMM XMTR circuit breaker.

      (4) Test system operation (refer to Section 23-2-0, Adjustment/Test).



VHF Communications Transmitter Installation
Figure 201

VHF COMMUNICATIONS ANTENNAS NO. 1 AND 3 - MAINTENANCE PRACTICES

1. Removal/Installation VHF Communications Antennas No. 1 or 3 (see Figure 201)

   A. Equipment Required:

      (1) Sealant EC-1663.

      (2) Aliphatic Naphtha.

      (3) Cheesecloth.

      (4) Petrolatum.

   B. Preparation.

      (1) Open VHF COMM NO. 1 and 2 RCVR and XMTR circuit breakers. (Hang warning signs on open circuit breakers.)

      (2) Locate the VHF-1 blade antenna on the lower fuselage centerline at station 460.

      (3) Locate the VHF-3 blade antenna on the upper fuselage centerline at Station 384.

   C. Remove VHF Communications Antenna No. 1 or 3.

      (1) Remove the 16 AN509-10R6 screws that secure the antenna to the airplane skin. (Bag and tag for installation.)

      (2) Apply sufficient pressure to part antenna and skin. Pull antenna out to expose coaxial cable connector. Disconnect coaxial cable from antenna. Remove plastic plug protector and rubber O-ring. (Bag and tag them for installation.)

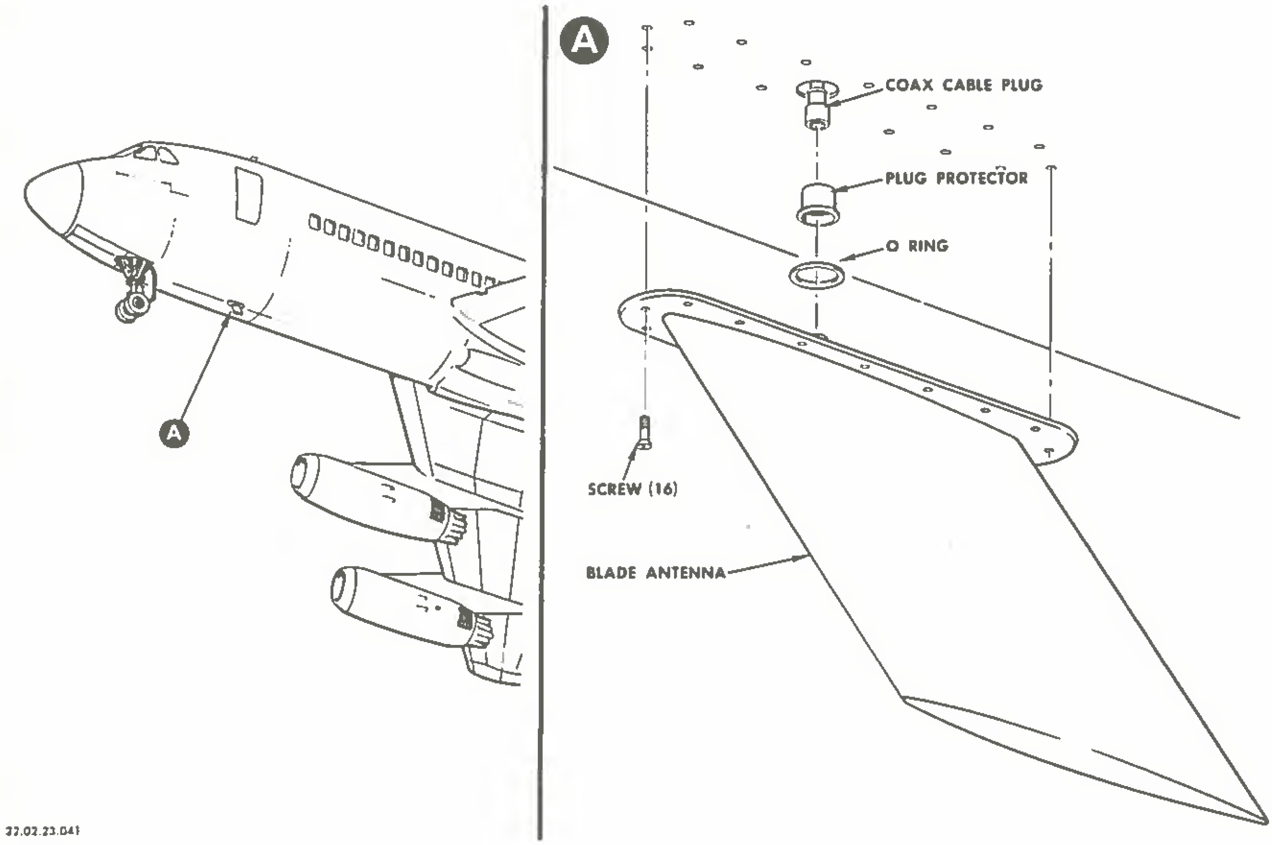
      (3) Wrap and tie coaxial cable connector in sheet vinyl plastic and reinsert in fuselage opening.

   D. Install VHF Communications Antenna No. 1 or 3.

      (1) Clean faying surfaces of airplane skin and antenna mounting base with aliphatic Naptha and cheesecloth. Remove all traces of old sealant and parting agent.

      (2) Apply EC-1663 sealant 1.0 inch wide on faying surface of skin. Apply petrolatum parting agent to match on mounting base of antenna.

      (3) Remove sheet vinyl from coaxial cable connector. Check inner surfaces of connector for dirt or metallic particles; clean if necessary. Install plug protector and O-ring.



VHF Communications No. 1 and 3 Blade
Antenna Installation
Figure 201

(4) Connect coaxial cable to antenna receptacle.

(5) Install 16 AN509-10R6 screws and tighten antenna base securely to airplane skin.

(6) Remove excess sealant.

(7) Close VHF COMM NO. 1 and 2 RCVR & XMTR circuit breakers and remove warning signs.

(8) Test system operation, (refer to Section 23-2-0, Adjustment/Test).

TWA TECHNICAL SERVICES
CONVAIR 880

Maintenance Service Letter

NBR. 64-2-C23
DATE ~~June 23,~~ 1964
SUBJECT: Installation, Top Mounted Cast Aluminum Blade Type VHF Antenna

This MSL revises and/or supplements the 880 Maintenance Manual and must be inserted facing Series 23-2-5, page 201.

REMOVE AND DESTROY PREVIOUSLY ISSUED MSL 62-222, filed at 23-2-5, page 201.

A top mounted cast aluminum VHF blade type antenna is being installed on the top center line at fuselage station 384 (#3 VHF antenna provision location) on all 880 aircraft as they pass through Base Overhaul. This antenna is connected to the No. 1 VHF system. The flush mounted #1 VHF antenna will be removed.

The top blade type VHF antenna installed for the No. 1 VHF system will provide better VHF coverage and more range than the flush mounted type and result in fewer service troubles.

The coax cables from the top flush mounted VHF antenna and the VHF #3 antenna provisions have been re-identified and the connections interchanged. In the electronics compartment radio rack, shelf B, the SCS-DCD audio transfer relay and the SCS-DCD antenna transfer relay are being removed and the wiring changed accordingly.

After this modification if any antenna problems are encountered in the No. 1 VHF system the top blade antenna should be checked and not the top flush mounted antenna.

VHF COMMUNICATIONS ANTENNA NO. 2 - MAINTENANCE PRACTICES

1. Removal/Installation VHF Communications Antenna No. 2 (see Figure 201)

   A. Equipment Required.

      (1) High lift aero stand to permit access to forward section of dorsal fairing.

      (2) Aliphatic naphtha.

      (3) Sealant, 3M EC-1663.

      (4) Petrolatum.

      (5) Cheesecloth.

   B. Preparation.

      (1) Open VHF COMM NO. 2 RCVR and XMTR circuit breakers. Hang a warning sign on opened circuit breakers.

      (2) Locate the VHF No. 2 flush antenna on the upper fuselage in the dorsal fairing at station 806.

   C. Remove VHF Communications Antenna No. 2.

      (1) Remove 33 AN509-10R6 screws securing the antenna plate to the dorsal fairing; see Detail A. Bag and tag screws for installation.

      (2) Remove four AN509-10R7 screws securing the antenna plate to the antenna cap. Bag and tag screws for installation.

      (3) Part and lift antenna plate carefully from fairing. Avoid distorting the antenna plate.

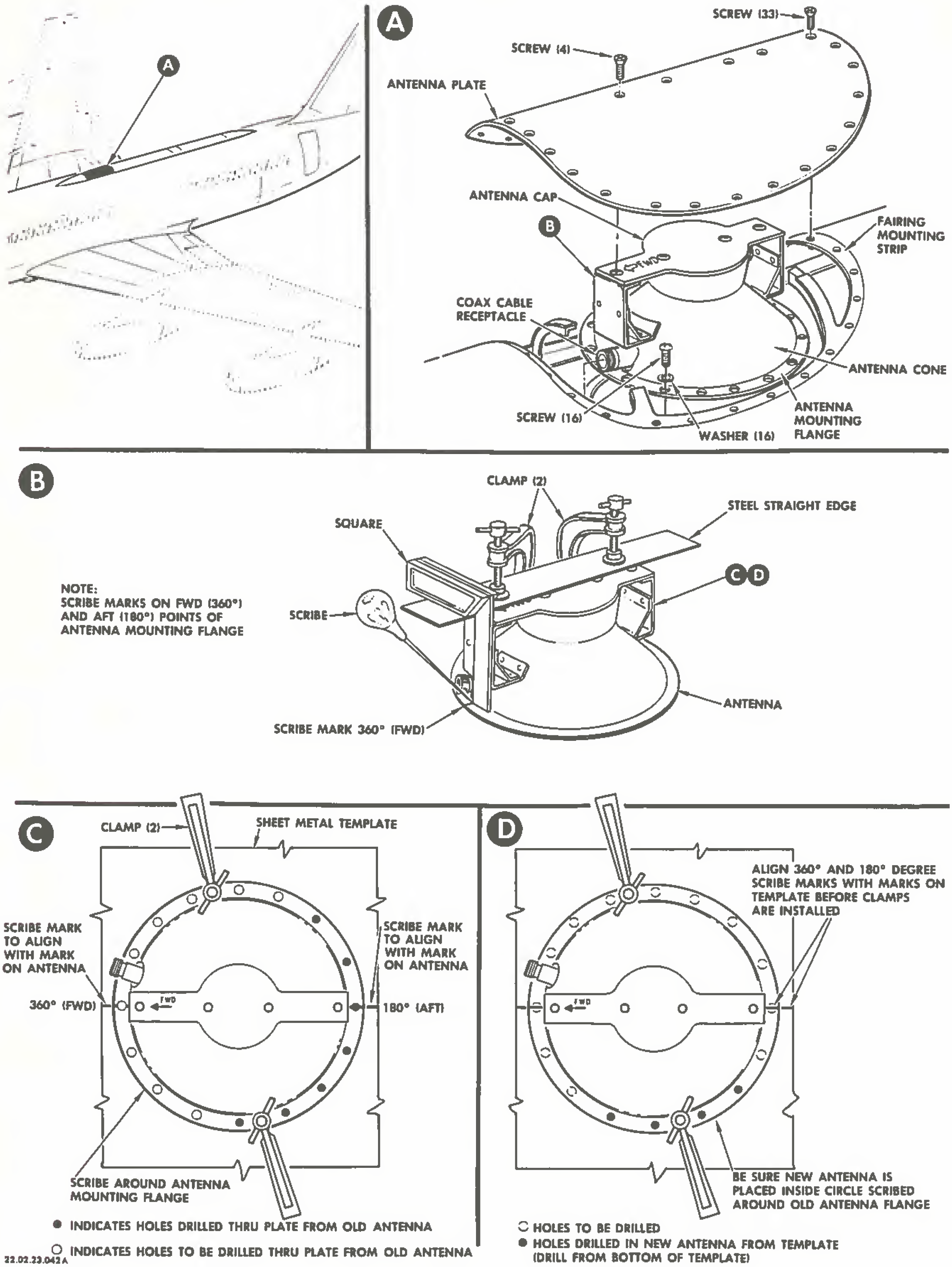
      (4) Disconnect coaxial cable from antenna.

      (5) Remove 16 NAS221-7 screws securing the antenna to the mounting area; note the AN960-10L washers installed under screw heads. Bag and tag hardware for installation.

         NOTE: Use the following steps when installing a new VHF No. 2 flush antenna without predrilled mounting holes.

      (6) Place a straight edge along the top of the old antenna in alignment with the arrow stenciled on the antenna cap and the centerline of the four screw holes in the cap; see Detail B.

      (7) Place a square over the straight edge, first on one end and then the other, and mark the antenna flange at the 360- and 180-degree points.



VHF Communications No. 2 Flush Antenna Installation
Figure 201

(8) Place the old antenna on a sheet metal template and clamp it securely; see Detail C.

(9) Scribe around the antenna mounting flange and scribe marks on the template in alignment with the scribe marks made on the antenna flange at the 360- and 180-degree points.

(10) Drill holes through the template to coincide with the old antenna flange mounting holes.

(11) Remove clamps and old antenna from sheet metal template.

(12) Scribe marks on new antenna flange using procedure outlined in steps (6) and (7).

(13) Place new antenna on template inside the scribed circle made from old antenna and align the 360- and 180-degree scribe points; clamp new antenna securely in this position; see Detail D.

(14) Drill mounting holes in new antenna flange to coincide with holes in template.

D. Install VHF Communications Antenna No. 2.

(1) Clean the faying surfaces of dorsal fairing mounting strip and antenna plate with aliphatic naphtha and cheesecloth. Remove all traces of old sealant and parting agent.

(2) Clean antenna cone assembly mounting base and matching contact area on airplane skin with aliphatic naphtha.

(3) Clean cap assembly and matching contact area on antenna plate with aliphatic naphtha.

(4) Apply EC-1663 sealant to antenna cone contact area of skin. Apply petrolatum parting agent to mounting base of antenna cone.

(5) Align antenna cone assembly over mounting holes in airplane skin.

(6) Insert 16 ea. NAS 221-7 screws with AN960-10L washers and tighten cone assembly securely to airplane skin.

(7) Remove excess sealant.

(8) Check inner surfaces of coaxial cable connector for dirt or metallic particles; clean if necessary.

(9) Connect coaxial cable to antenna.

(10) Apply EC-1663 sealant to faying surface of dorsal fairing mounting strip.

(11) Apply petrolatum parting agent to matching faying surface on antenna plate.

NOTE: Do not apply sealant or parting agent to antenna cap assembly or its matching area on antenna plate.

(12) Install 4 ea. AN509-10R7 screws through antenna plate into antenna cap assembly; tighten securely.

(13) Install 33 ea. AN509-10R6 screws through antenna plate into fairing mounting strip; tighten securely.

(14) Remove excess sealant.

(15) Close VHF COMM NO. 2 RCVR and XMTR circuit breakers and remove warning signs.

(16) Test system operation. Refer to 23-2-0, Adjustment/Test.

SELECTIVE CALLING SYSTEM - DESCRIPTION AND OPERATION

1. General

The selective calling system, SELCAL, allows the ground station operator to call a single airplane of a group of airplanes, thus relieving pilots of having to constantly monitor ground station radio frequencies. Figure 1 shows a block diagram of the selective calling system.

The ground station operator selects a code of four audio frequency tones and activates the ground transmitter. The airborne selective calling unit is connected to the audio outputs of high frequency and VHF receivers. When a communications receiver in the airplane receives a correct code of four tones, the selective calling unit sounds a chime and flashes a warning light to warn flight personnel to monitor the receiver.

2. Power Requirements

The selective calling system requires: 15 volt-amperes at 115 volts, ac, 400 cps; and 21 watts at 27.5 volts dc. This power is taken from No. 1 and No. 2 normal radio dc buses; and from No. 1 and No. 2 normal ac radio buses, phases A and B. No. 1 and No. 2 normal dc radio buses are energized by the 28-volt essential dc bus through the No. 1 normal relay and the No. 2 normal relay, respectively.

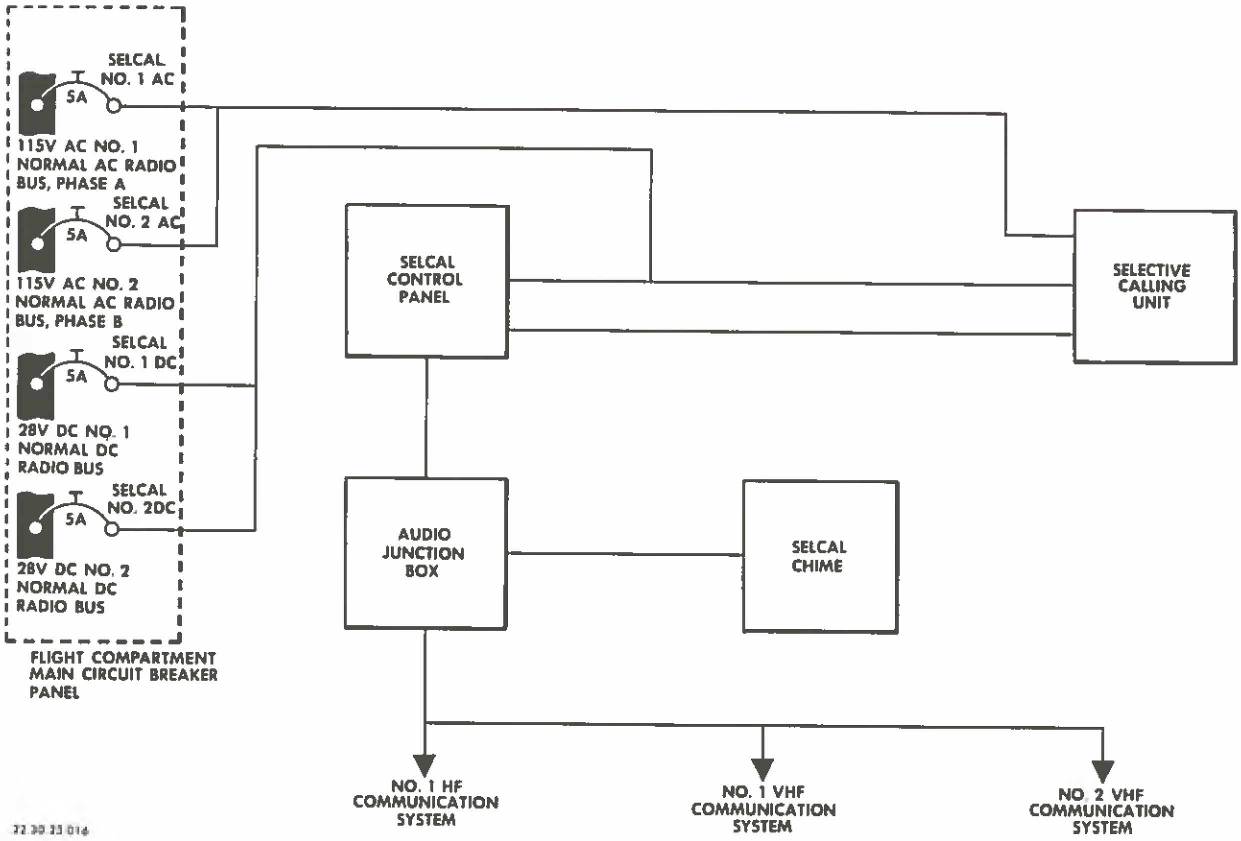
3. Circuit Protection

The selective calling system is protected by four 5-ampere circuit breakers on the main circuit breaker panel.

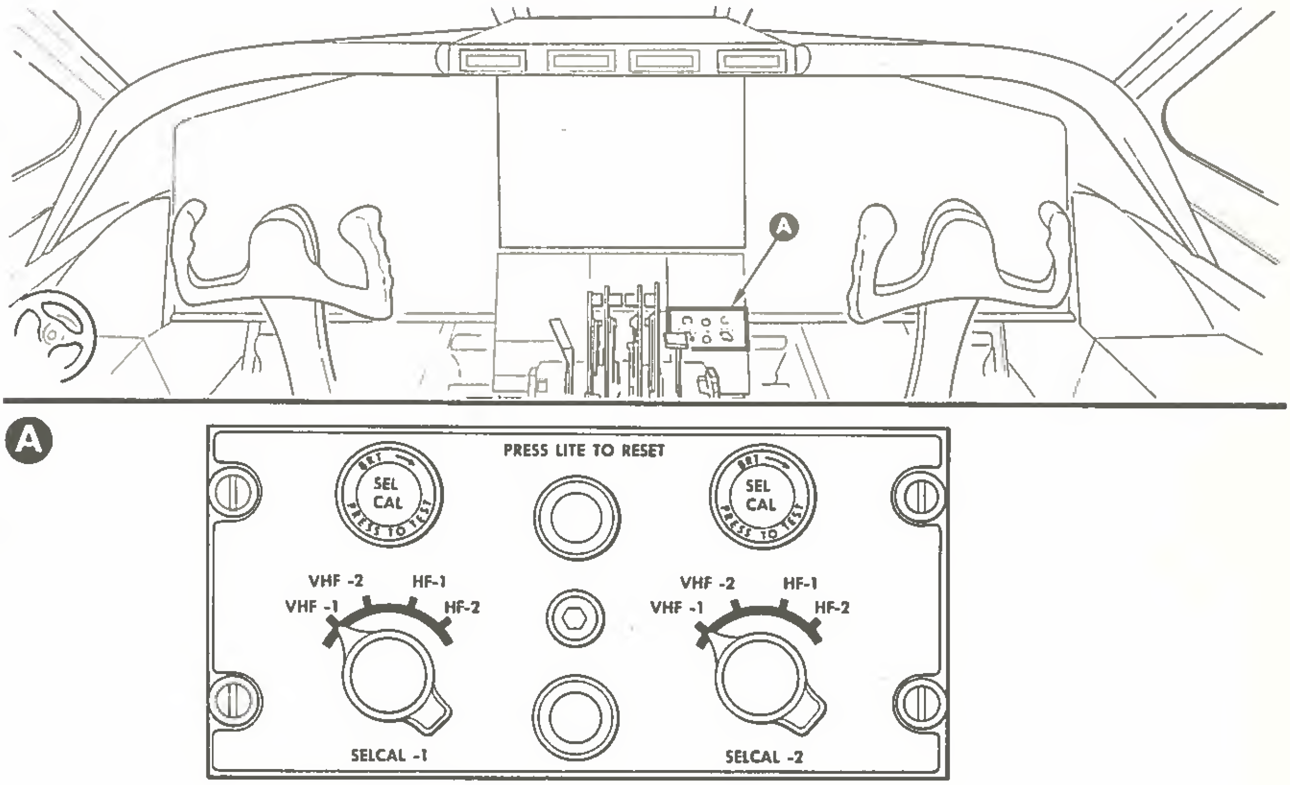
4. Control Panel

The Gables G-556 SELCAL control panel on the forward pedestal contains two receiver selector switches and two lights. A light is associated with each selector switch. The communications system receiver on which SELCAL warning is to be received is selected by one or both of the selector switches. Switch positions are marked VHF-1, VHF-2, HF-1, and HF-2. A ground station call on the selected communications receiver illuminates a flashing light on the control panel and sounds the left SELCAL chime in the flight compartment.

The lights are part of reset switch assemblies. Before answering a radio call, the operator can extinguish the warning light and still the chime by pushing on the light to reset the SELCAL system. The system is then ready for the next call. Having finished a communication, the operator need not monitor the receiver until another call comes in. See Figure 2 for an illustration of the SELCAL control panel.



Selective Calling System Block Diagram
Figure 1



SELCAL CONTROL PANEL

22 30 23 017

Selective Calling System Control Panel
Figure 2

5. Selective Calling System Unit (see Figure 3)

The Collins 456C-1 selective calling unit is installed on a shock mount behind the forward coat closet, at the top of the compartment in which the forward escape slide is stored. The unit is removed and installed, and code settings are made, through a rectangular opening in the aft bulkhead of the flight compartment at the left side. The removable hand-hold at left-hand side of the forward entrance to the cabin allows access to the rear of the SELCAL unit mount. The mount is also partially accessible from the escape slide storage compartment.

Electrical connections are made through a receptacle at the rear of the shockmount. Two knurled nuts secure the unit to the shockmount.

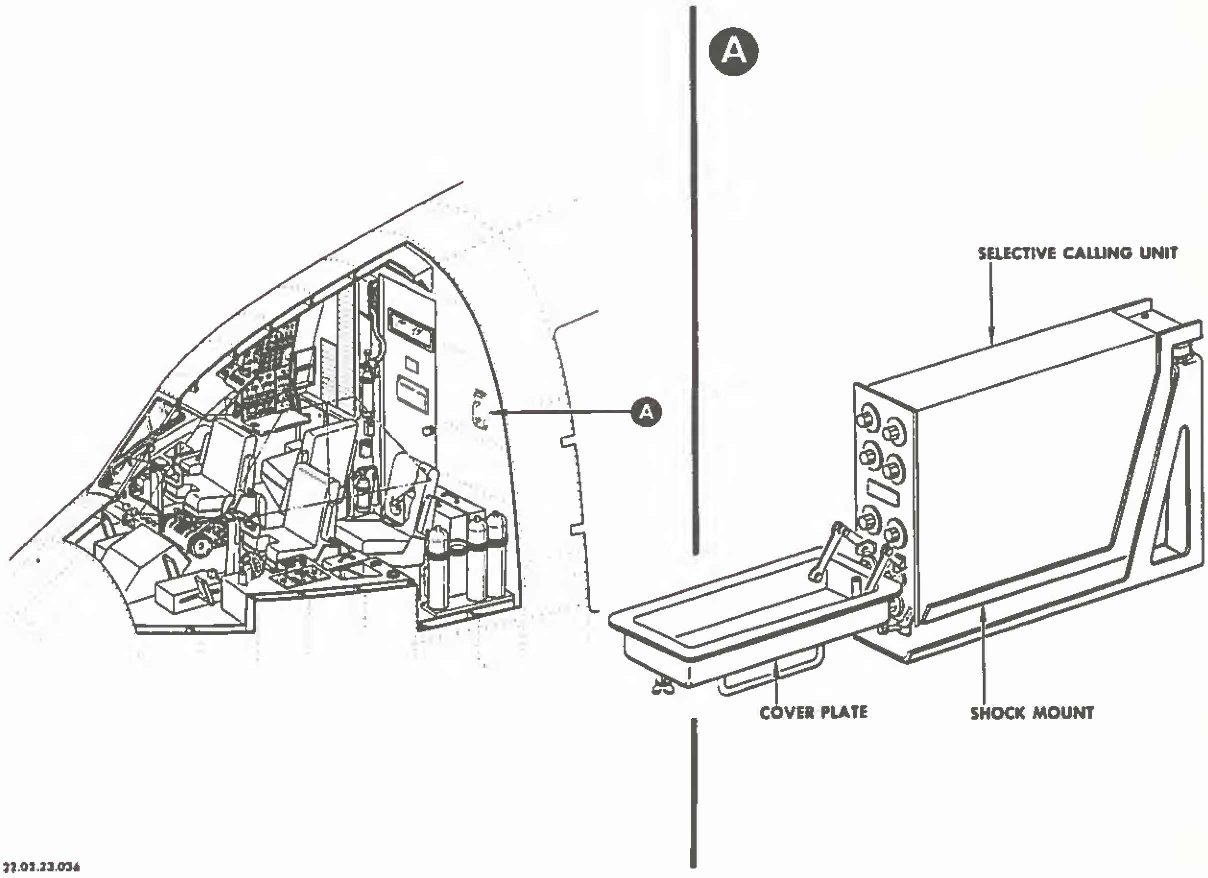
A handle is attached to a cover plate on the front panel of the unit. Two winged Dzus fasteners secure the cover plate to the front panel of the case. The cover plate swings down on hinged supports to allow access to eight selector switch control knobs on the front panel of the case.

The selective calling unit circuitry consists of two decoder channels. The front panel selector switches allow changing of calling codes without removing the unit from the shockmount. Four switches are provided for each channel.

The selective calling unit is preset for operation by setting tone 1, tone 2, tone 3, and tone 4 switches in each channel to the four-letter code or codes assigned to the aircraft. The airplane HF or VHF receivers detect the tone code modulated SELCAL signals sent by the ground station, and apply the audio tones to the decoding channels of the selective calling unit. Only the preselected code energized the airplane SELCAL system. The input to the SELCAL system is from the second detector of the radio receiver, where the audio signal voltage level is not affected by the volume control of the receiver. The signal input level to the SELCAL system is preset in the radio receiver. The high input impedance of the selective calling unit does not load the receiver audio circuits.

6. Selective Calling System Chime

When the audio tones received by one of the communications receiver are in correct time sequence and duration, the decoder circuits of the selective calling unit energize circuits that sound the left SELCAL chime in the flight compartment. The chime and the warning lights on the SELCAL control panel indicate to the pilots that a ground station is calling the airplane. A chime for calls from the cabin attendant is installed to the right of the selcal chime in the ceiling of the flight compartment. The tones of the chimes differ and distinguish them.



23.03.23.036

Selective Calling Unit
Figure 3

SELECTIVE CALLING SYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. SELCAL OPERATIVE ON ONE CHANNEL BUT NOT ON THE OTHER	
A. SELCAL decoder unit faulty.	Check settings of code selector switches on front panel. Arrange for a ground station to call the airplane code. If only one channel receives the code, replace the SELCAL unit.
B. Receiver system faulty.	Test the operation of both VHF communications receivers. Trouble shoot the system that fails to provide SELCAL code signals.
C. Control panel selector switch faulty.	Arrange for calls on the airplane code and test operation on both channels and all available receiver systems. Replace the control panel if the selector switches do not make correct selections.
D. Wrong code set into a channel.	Make correct code selection on the front panel of the SELCAL unit and retest the system.
E. No electrical power at control panel or SELCAL unit.	Remove control panel and test for 28-volts-dc on pins A and V of control panel receptacle. Remove SELCAL unit and test for 28-volts-dc on pins No. 31 and 32, and for 115-volts-ac on pins No. 3 and 18 of the rack receptacle. If voltage is lacking at any of these points, test continuity from receptacle pins to the corresponding circuit breakers. Repair or replace open or shorted wires.
2. SELCAL LIGHT OPERATION NORMAL BUT NO CHIME SIGNAL	
A. SELCAL chime faulty or open-circuited wire.	Momentarily apply a voltage of 28-volts-dc to terminal No. 16 in the audio junction box. If the SELCAL chime does not sound, remove the

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

2. SELCAL LIGHT OPERATION NORMAL BUT NO CHIME SIGNAL (CONT)

	chime. Connect a voltmeter to wire No. RZ718D20 at the chime and apply a steady voltage of 28-volts-dc to stud No. 16 on terminal board AE of the audio junction box. Apply the voltage long enough to read the voltmeter at the chime. If there is voltage at the chime, install another chime. If no voltage at the chime, repair the open-circuited wire.
	If the chime sounds when voltage is applied to stud No. 16 on terminal board AE of the audio junction box, test continuity from this terminal to pins No. 11 and 26 of the SELCAL unit rack receptacle. Replace or repair faulty wiring.

3. SELCAL CHIME SOUNDS BUT NO LIGHT

A. Lamp burned out.	Press the lamp to test. Replace burned out lamp.
B. Control panel faulty.	Remove SELCAL unit and check continuity through the control panel lamps by measuring resistance from rack pins No. 13 and 28 to ground. The resistance in either circuit should be about that of the lamp.
	If no continuity, remove the control panel and test continuity from pin No. 13 to pin F of the control panel receptacle, and from pin No. 28 of the rack to pin H of the control panel receptacle. If there is continuity, replace the control panel with a known good panel.
C. Wiring faulty.	If the previous test shows open circuit or circuits, repair or replace the wiring.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
3. SELCAL CHIME SOUNDS BUT NO LIGHT (CONT)	
D. SELCAL unit faulty.	If there is continuity from the rack to the control warning lamps, replace the SELCAL unit with a known good one.

SELECTIVE CALLING SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Selective Calling System

   A. Equipment Required - External ac power unit.

   B. Preparation.

      (1) Connect the external ac power unit and switch on ac and dc power.

      (2) Close the following circuit breakers:

         (a) SELCAL NO. 1 AC, SELCAL NO. 2 AC; SELCAL NO. 1 DC; SELCAL NO. 2 DC.

         (b) VHF COMM 1 RCVR DC; VHF COMM 1 XMTR DC; VHF COMM 2 RCVR DC; VHF COMM 2 XMTR DC.

         (c) AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT & FLT ENGR DC.

         (d) Six HF COMM, AC and DC.

      (3) Turn on the HF and VHF systems for reception of pre-arranged signals from a transmitting station having a functioning SELCAL system.

   C. Test the SELCAL system.

      (1) Test the SELCAL system on several codes, including the code or codes assigned to the airplane. When the ground station calls, the SELCAL chime should sound and the SELCAL light should flash on the control panel. The SELCAL chime is the left-hand chime in the flight compartment.

      (2) Press the TEST TO RESET light assembly after each call to extinguish the light and still the chime.

      (3) Set the decoder channels for tests as follows:

         (a) Release the two winged dzus fasteners on the front panel of the SELCAL unit and swing the front cover plate down for access to the code-setting switches.

         (b) Set the letters on the skirts of the knobs of the SELCAL unit to the pre-arranged code before each test. Set both channels to the same code.

(4) Tune the receivers to the pre-arranged frequency channels on which SELCAL tests are to be made.

(5) Trouble shoot the SELCAL system if required results are not obtained.

(6) When all tests are satisfactory set both channels of the SELCAL unit to the code assigned to the airplane, secure the front cover plate of the unit, and turn off the communications receivers.

SELECTIVE CALLING SYSTEM COMPONENTS - MAINTENANCE PRACTICES

1. Removal/Installation SELCAL Control Panel

   A. Equipment Required - None.

   B. Preparation. Open SELCAL NO. 1 and 2 AC and DC circuit breakers. Hang warning sign on the opened circuit breakers.

   C. Remove SELCAL control panel.

      (1) Release the Allen-head injector-extractor screw and withdraw the control panel.

      (2) Put masking tape over the receptacle to protect it.

   D. Install the SELCAL control panel.

      (1) Remove the masking tape from the control panel receptacle.

      (2) Position the control panel in the space provided, engage the guide pins, and secure the injector-extractor screw.

      (3) Close circuit breakers and remove the warning sign.

      (4) Test the SELCAL system operation, (refer to Section 23-3-0, Adjustment /Test).

2. Removal/Installation SELCAL Control Panel Receptacle Box

   A. Equipment Required - None.

   B. Preparation. Open SELCAL NO. 1 and 2 AC and DC circuit breakers. Hang warning sign on opened circuit breakers.

   C. Remove Control Panel Receptacle Box.

      (1) Remove SELCAL control panel, follow instructions given in paragraph 1. C.

      (2) Release four Camloc fasteners that secure the box to the mounting frame and pull out for access to receptacle mounting screws.

      (3) Remove four screws that secure the receptacle to the box. (Bag and tag screws for installation.)

      (4) Put masking tape over receptacle to protect it.

D. Install Control Panel Receptacle Box.

(1) Remove tape from receptacle.

(2) Secure receptacle to box with screws from step C. (3).

(3) Place box in opening and secure four Camloc fasteners.

(4) Position the SELCAL control panel in space provided, engage guide pins and secure the injector-extractor screw.

(5) Close circuit breakers and remove warning signs.

(6) Test system operation, (refer to Section 23-3-0, Adjustment/Test).

3. Removal/Installation SELCAL Decoder Unit

A. Equipment Required - None.

B. Preparation. Open SELCAL No. 1 and 2 AC and DC circuit breakers. Hang warning sign on the opened circuit breakers.

C. Remove SELCAL decoder unit. Release the knurled thumb nuts and withdraw the SELCAL unit through the rectangular opening at the left-hand side of the aft flight compartment bulkhead.

D. Install SELCAL decoder unit.

(1) Position the SELCAL unit on the mounting base through the rectangular opening on the aft flight compartment bulkhead, and secure the thumb nuts.

(2) Close the SELCAL circuit breakers and remove the warning sign.

(3) Test operation of the SELCAL system, (refer to Section 23-3-0, Adjustment/Test).

SELECTIVE CALLING SYSTEM CHIME - MAINTENANCE PRACTICES

1. Removal/Installation SELCAL Chime (see Figure 201)

   A. Equipment Required - None.

   B. Preparation. Open SELCAL No. 1 and 2 AC and DC circuit breakers. (Hang warning signs on open circuit breakers.)

   C. Remove SELCAL Chime.

      (1) Remove two dome nuts and washers from sound bar. Remove sound bar. Bag and tag nuts and washers for installation.

      (2) Remove the two phillips-head screws that secure chime to overhead panel.

      (3) Lower chime to gain access to wire terminals.

      (4) Remove nuts and washers attaching the two wires to chime terminals. Tag wires for installation.

   D. Install SELCAL Chime.

      (1) Remove sound bar from replacement chime.

      (2) Place wires on chime terminals according to previously affixed tags, and secure with washers and nuts.

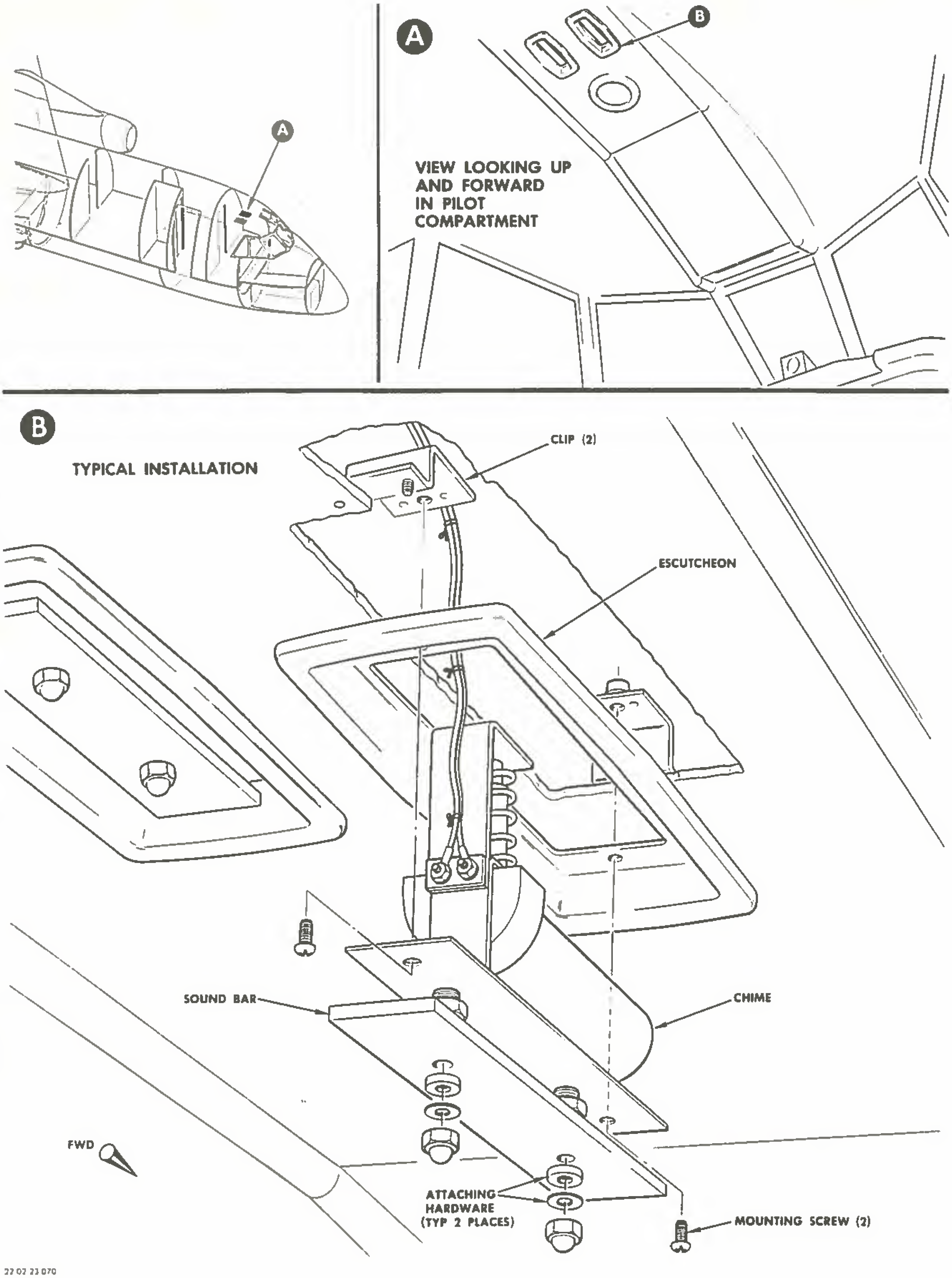
      (3) Position chime over mounting holes.

      (4) Install the two phillips-head screws.

      (5) Install sound bar and secure with washers and dome nuts.

      (6) Remove warning signs and close SELCAL circuit breakers.

      (7) Test operation of SELCAL system, (refer to Section 23-3-0, Adjustment/Test).



Selective Calling System Chime Installation
Figure 201

PUBLIC ADDRESS SYSTEM - DESCRIPTION AND OPERATION

1. General

The public address system permits pilots and stewardesses to address passengers, and it permits reproduction of music from a tape reproducer.

The system consists of a pilots' handset and control panel installation, forward and aft cabin handset and control panel installations, a priority relay, a public address amplifier, and 23 loudspeakers installed in the hatracks in the cabin. See Figure 1 for block diagram of the system.

A priority system is built into the public address system. Pilots' voice communications have priority over music and over voice announcements from either of the cabin control positions. The forward cabin control position has priority over music and voice announcements from the aft cabin control position. The aft cabin control position has priority over music for voice announcements.

2. Power Requirements

The public address system requires approximately 80 watts at 28 volts dc for full audio output. An insignificant amount of 115-volt ac power is used for testing. Dc power is taken from the emergency dc radio bus. Ac power is taken from the emergency radio bus, phase "A".

3. Circuit Protection

The public address system is protected by two 5-ampere circuit breakers on The main circuit breaker panel.

4. Control Panels (see Figure 2)

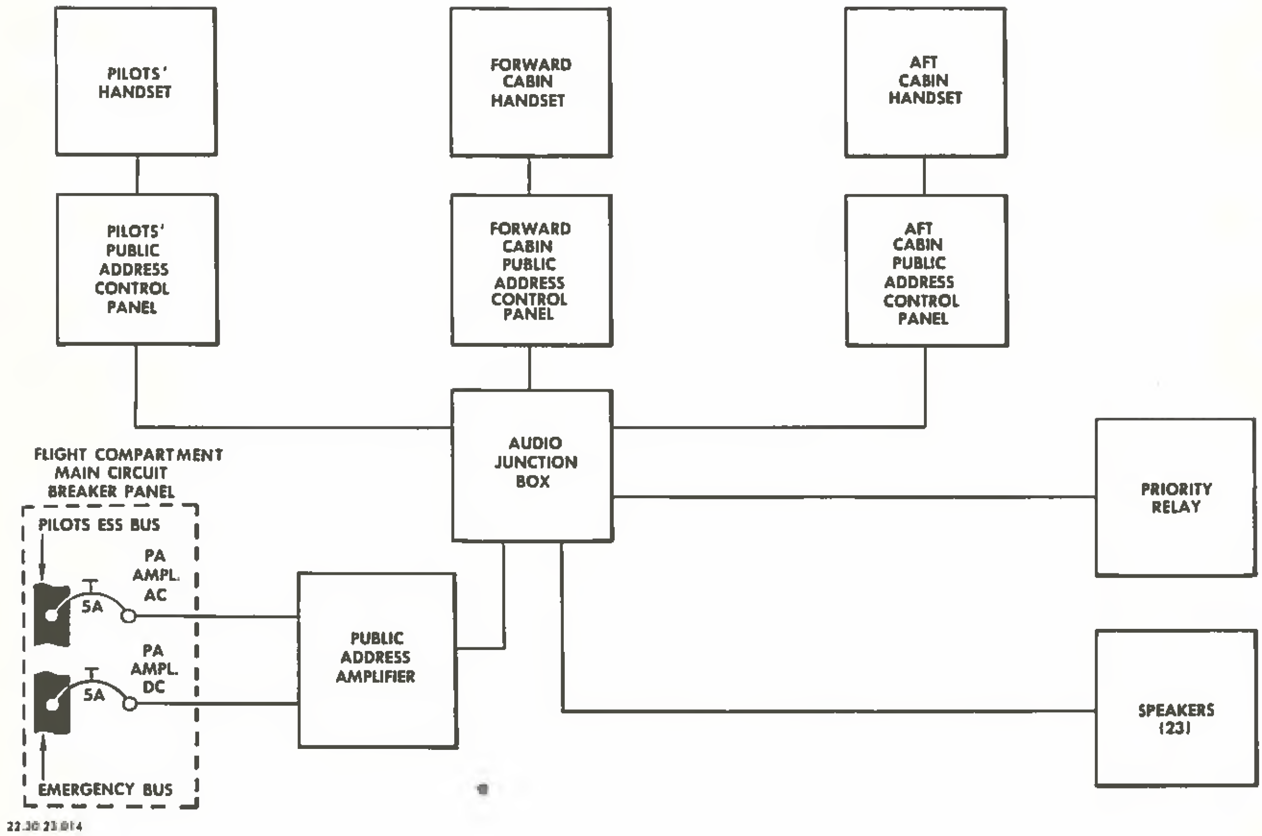
The three public address control panels carry vu-meters, volume controls, and call buttons. The panels are edgelighted by lamps in the panels.

A. Pilots' Control Panel.

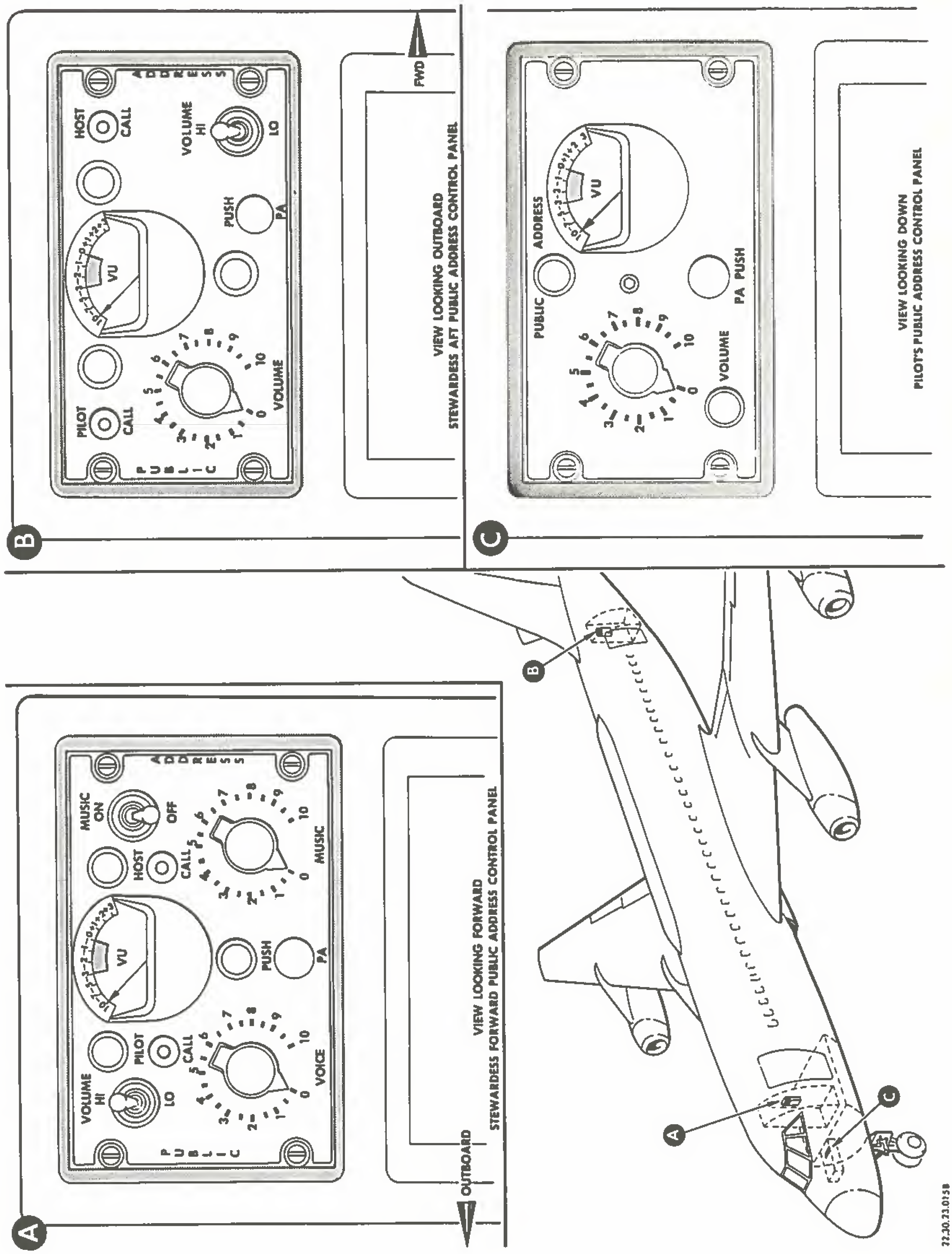
The pilots' control panel is installed on the left aft part of the pilots' pedestal. This panel has a volume control switch only for microphone audio. A pushbutton switch assembly connects pilots' voice into the public address system. Communications from this panel interrupt cabin music and voice communications being made from either of the cabin positions.

B. Forward Cabin Control Panel.

The forward cabin public address control panel in the forward buffet area contains the MUSIC ON select switch and the volume control for



Public Address System, Block Diagram
Figure 1



Public Address System Control Panels
Figure 2

level of music in the cabin, when the tape reproducer is installed. A voice volume control adjusts the level for voice announcements. Voice communications from this control panel interrupts cabin music and voice announcements from the aft cabin control panel.

C. Aft Cabin Control.

The aft cabin public address control panel is installed in the aft buffet area. This control panel contains a volume control for handset voice announcements. Voice announcements from the aft control panel interrupt reproduction of music, if the tape reproducer is installed.

5. Handsets (see Figure 3)

A handset is installed near each control panel position. Switches on the handset hooks automatically switch the handsets to the interphone system. To talk over the public address amplifier, operators must depress the PA light assembly button on the control panels to connect the handsets to the public address system. The coiled handset connector cables stow in conduits near the handsets. Cabin handsets are installed on swivel doors. When the handsets are not in use, the doors conceal them from view.

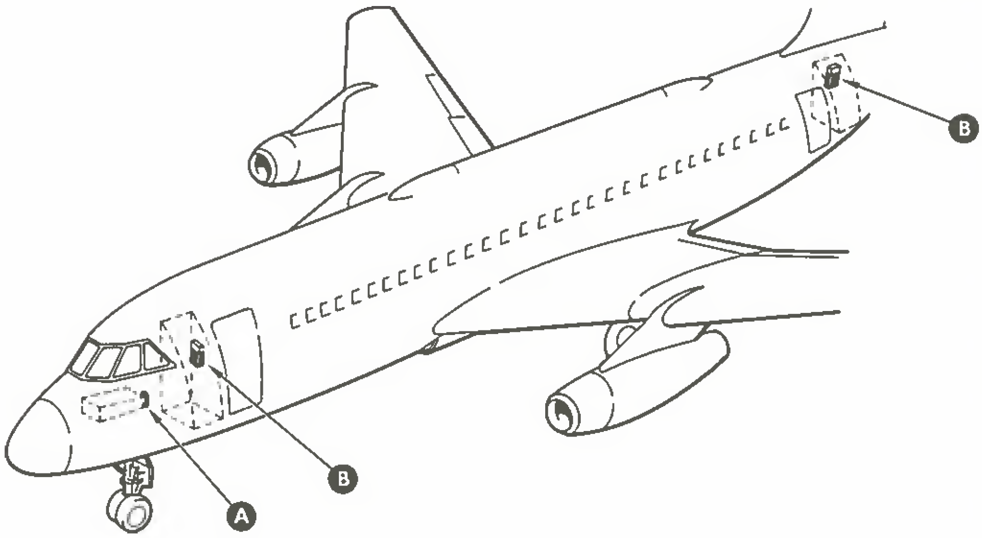
The microphones in the handsets are dynamic types that provide excellent voice quality. Transistor amplifiers are built into the handsets. Vu-meters and volume controls on the control panels permit adjustment for differences in handset output levels due to individual voices.

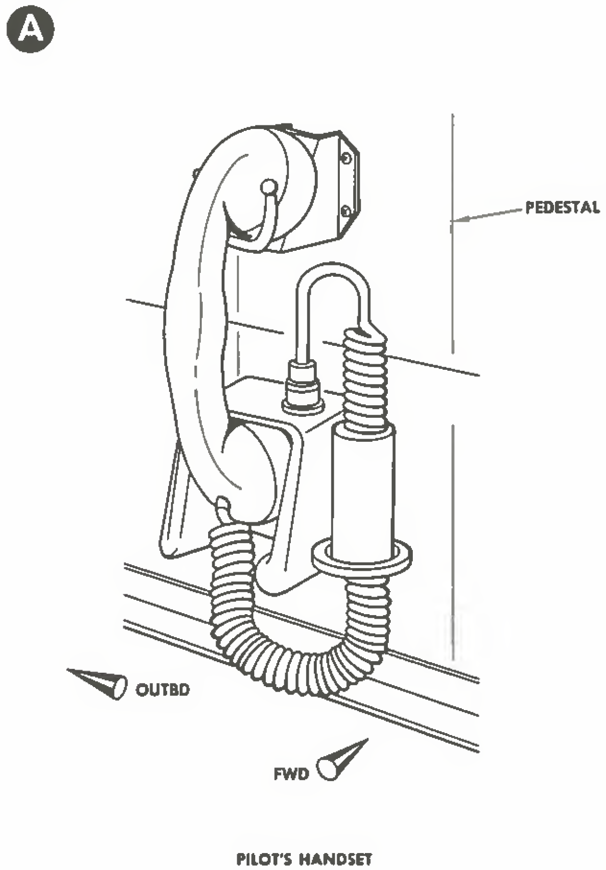
6. Amplifier

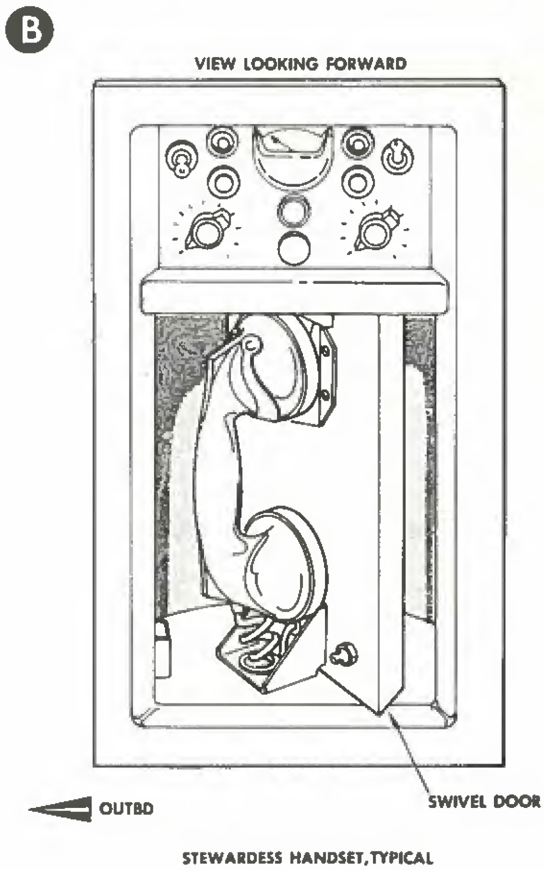
The Collins 346D-1 Audio amplifier provides voice announcements and music for the passengers. The amplifier unit is installed in the electronics compartment. The input circuits are selected, and the output power to the speakers is controlled by the three control panels previously described. Screwdriver-adjusted treble and base tone controls on the amplifier chassis must be preset before the unit is installed.

The amplifier unit is housed in a metal case and is secured to the mounting rack by a knurled nut. The side and top of the case are perforated for ventilation. Electrical connections are made through a receptacle at the rear of the mounting rack. A handle is provided on the front panel. A meter on the front panel can be switched into the amplifier output circuit by a switch on the lower part of the panel.

The amplifier is completely transistorized. Input circuits are selected on the priority basis determined by the control panels. Maximum audio output power is 40 watts. The audio output transformer is tapped to enable matching of output impedance to the load impedance presented by the cabin speakers.







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Public Address System Handsets, Typical
Figure 3

7. Loudspeakers

Twenty-three Jensen P6V six-inch speakers are installed in the cabin. An audio impedance matching transformer is mounted on each speaker. The primary windings of the speaker transformers are connected in parallel to match amplifier output impedance. The primary windings of the speaker transformers are tapped. By changing the taps, individual speakers can be adjusted for greater or less output required by areas in the cabin. The listening level throughout the cabin can thus be made uniform.

One speaker is provided for each four seats in the double row seating arrangement. Speakers can be removed, adjusted, and replaced without disturbing cabin trim. Speaker wires terminal strips are coded to maintain correct speaker phasing.

PUBLIC ADDRESS SYSTEM - TROUBLE SHOOTING

PROBABLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. PUBLIC ADDRESS SYSTEM INOPERATIVE	
A. Circuit breaker open.	Check PA AMPL - AC and DC circuit breakers and close if necessary.
B. Amplifier faulty.	Check amplifier by test procedure, (refer to Adjustment/Test). If faulty, replace.
C. Associated wiring faulty.	Check continuity of audio output wiring. Check from pin 14 (common output lead) of amplifier plug, or from pin 18 of rack plug to No. 1 terminals of speakers. Check from pin 22 (125-ohm impedance lead) of amplifier plug or pin 19 of rack plug to terminals No. 2 of speakers. Repair or replace open or shorted wiring.
2. SINGLE SPEAKER INOPERATIVE	
A. Transformer faulty.	Check transformer windings. If defective replace speaker.
B. Voice coil open.	Check continuity of voice coil winding. If open replace speaker.
3. NO SIDETONE WHEN TALKING	
A. Faulty amplifier	Check amplifier by test procedure, (refer to Adjustment/Test). If faulty replace amplifier and check system operation.
B. Faulty control panel.	Replace control panel with one of known quality and check system operation. If operation is normal send faulty unit to overhaul.
4. HANDSET ON HOOK DOES NOT SWITCH CONTROL POSITION TO INTERPHONE FROM PA SYSTEM	
A. Hook switch faulty.	Check continuity of switch contacts in both positions. If continuity

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
4. HANDSET ON HOOK DOES NOT SWITCH CONTROL POSITION TO INTERPHONE FROM PA SYSTEM (CONT)	
	incorrect, replace switch and check operation.
B. Control panel faulty.	Replace control panel with one of known quality and check system operation. If operation is normal send faulty unit to overhaul.
5. VU METER DOES NOT INDICATE OR IS INACCURATE	
A. Faulty meter.	Replace control panel with one of known quality and check system operation. If operation is normal send faulty unit to overhaul.
B. Faulty wiring to meter.	Check continuity of meter wiring. If no continuity replace control panel.
6. NO MICROPHONE OR HANDSET RECEIVER AUDIO AT A CONTROL POSITION	
A. Handset amplifier faulty.	Check system wiring to handset. If good replace handset. Check system operation.
B. Faulty control panel.	Replace control panel with one of known quality and check operation. If operation is normal send faulty unit to overhaul.
C. Airplane wiring.	Check system wiring for continuity.If no continuity, repair or replace faulty wiring as necessary.
7. SWITCH DOES NOT START TAPE REPRODUCER OPERATION	
A. Faulty switch.	Check switch contacts for continuity in both positions. If no continuity replace control panel and check operation.
B. Faulty wiring.	Check wiring between control panel and tape reproducer unit. If no continuity repair or replace wiring.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
7. SWITCH DOES NOT START TAPE REPRODUCER OPERATION (CONT)	
C. Tape reproducer faulty.	Trouble shoot tape reproducer system, (refer to Section 23-6-0). Repair or correct and check operation.
8. VOLUME CONTROLS NOT EFFECTIVE	
A. Faulty control panel.	Replace control panel with one of known quality and check operation. If operation is normal send faulty unit to overhaul.
9. CONTROL PANELS DO NOT ASSUME CORRECT PRIORITY	
A. Faulty priority relays.	Check power and ground circuits to relays. If normal replace relays and check operation.
B. Faulty control panel.	Replace control panel with one of known quality and check operation. If operation is normal send faulty unit to overhaul.
C. Control panel switch faulty.	Check continuity of switch contacts in both positions. If no continuity replace control panel and check operation.
D. Associated wiring faulty.	Check system wiring for open or shorted wires. Repair or replace faulty wiring.

PUBLIC ADDRESS SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Public Address System (see Figure 201)

   A. Equipment Required. External AC power unit.

   B. Preparation.

      (1) Connect external ac power unit and switch on ac and dc power.

      (2) Close PA AMPL - AC and DC circuit breakers.

      (3) Gain access to public address amplifier on shelf C in electronics compartment.

   C. Test Public Address System.

      (1) Actuate the NORM-CAL switch on the front panel of the amplifier to CAL position.

      (2) Record the position of the slot of the screwdriver-actuated MASTER GAIN control to the left of the test switch.

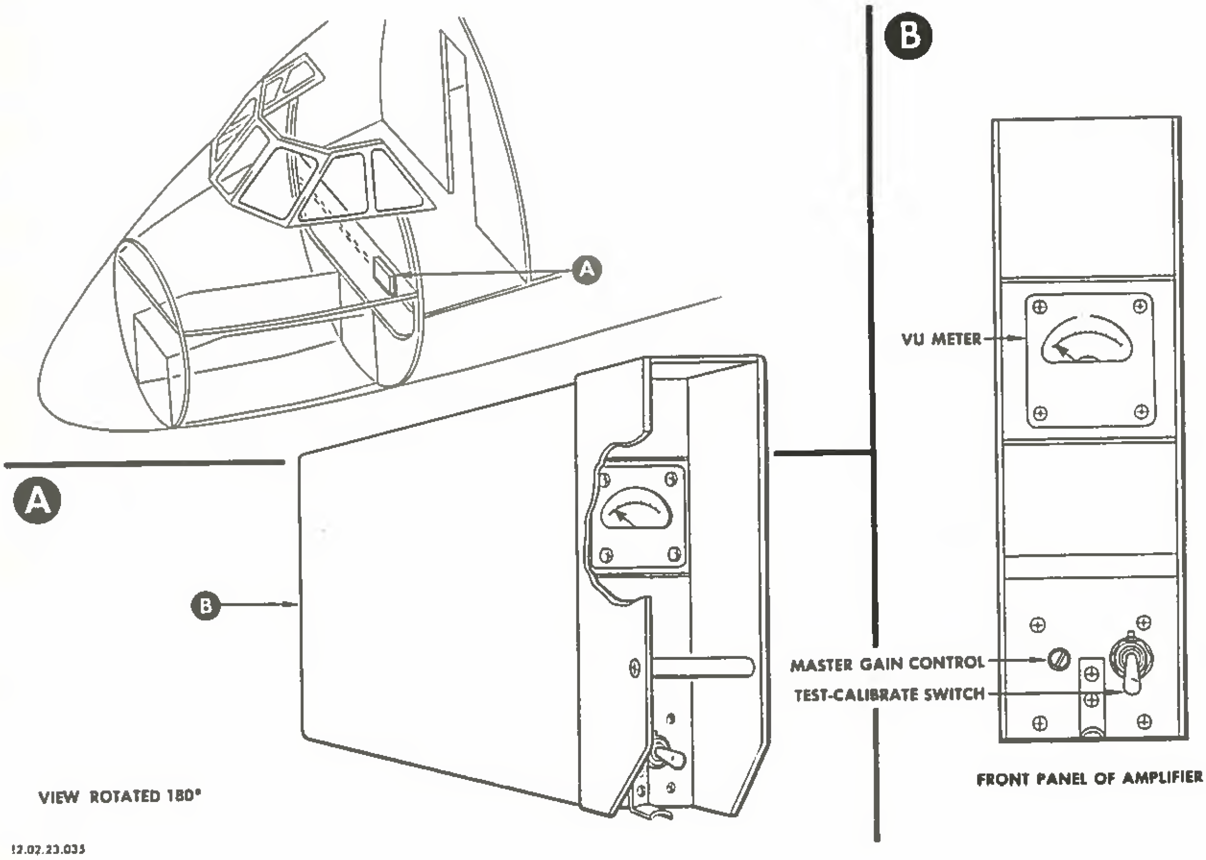
      (3) Reset the master gain control, if necessary, so that the vu-meter indicates 10 on the scale. This reading indicates that the amplifier is capable of 10 db gain. Release the test switch.

      (4) Note the amount of change in the position of the screwdriver slot. A large change in the position of the slot in the gain control potentiometer shaft indicates rapid degeneration in amplifier performance, and the amplifier should be replaced.

      (5) Use the handset at each of the three control positions in the flight compartment and cabin to test operation of the system. Adjust the volume controls to a suitable audio level. Voice should be of good quality.

      (6) Speak over the loudspeaker system from each control position by pressing the PUSH PA switch after lifting the handset from the hook. Voice should be clear and undistorted.

      (7) While speaking from the forward stewardess position, operate from the pilot's position. The pilot's position should interrupt the voice from the forward stewardess position.



Public Address Amplifier
Figure 201

(8) Similarly speak from the forward stewardess position while speaking from the aft stewardess position. The forward stewardess position should assume priority.

(9) The lights in the PUSH PA switch assemblies on the control panels should extinguish when the handsets are placed on the hooks.

(10) If these results are not obtained, troubleshoot the system.

PUBLIC ADDRESS SYSTEM LOUDSPEAKERS - MAINTENANCE PRACTICES

1. Removal/Installation Public Address System Loudspeakers (see Figure 201)

A. Equipment Required - None.

B. Preparation. Open PA AMPL - AC and DC circuit breakers. (Hang a warning sign on opened circuit breaker.)

C. Remove Loudspeaker.

(1) Press on the rim of the speaker grill and rotate the grill clockwise to free the attaching clips.

(2) Remove the cover screws from the inner side of the hatrack, remove the cover, and remove the speaker sound pad. (Bag and tag screws for installation.)

(3) Disconnect the wire from terminals on the speaker. (Attach identification tags to wires.)

(4) Remove the attaching screws and nuts and lift out the speaker. (Bag and tag screws for installation.)

D. Install Loudspeaker.

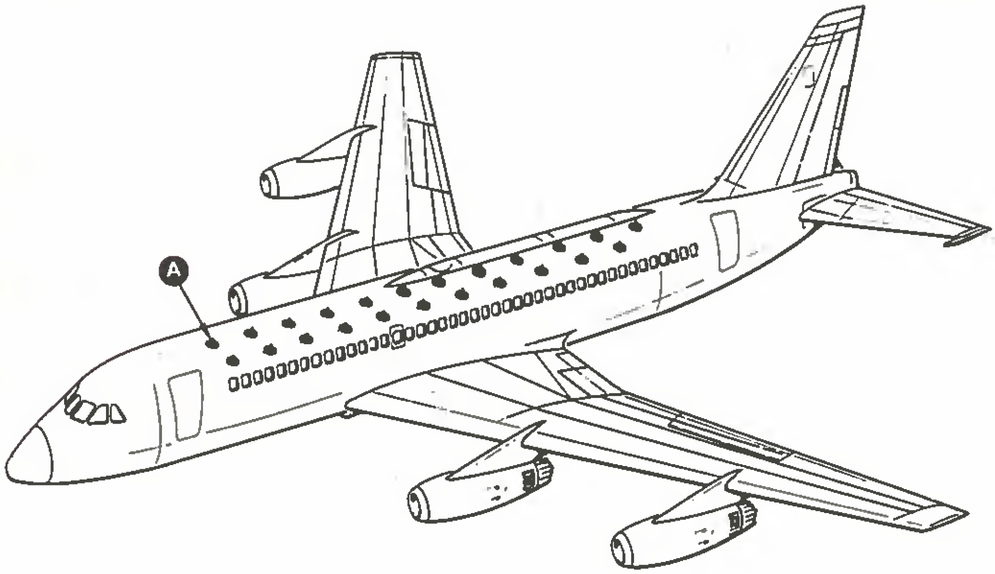
(1) Place speaker in position and install four attaching screws and nuts.

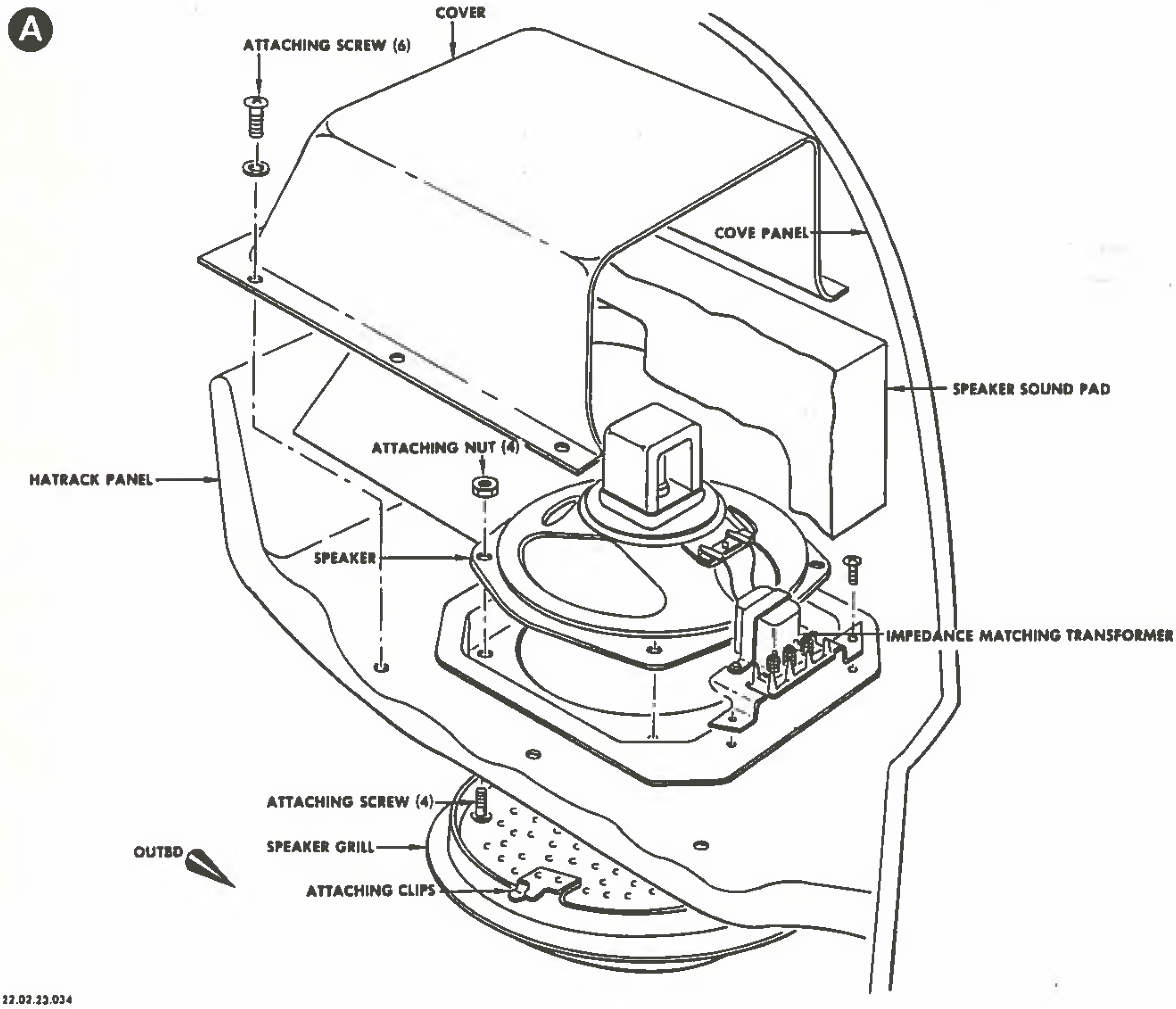
(2) Connect wire terminals. Follow color coding and identification tags.

(3) Replace speaker sound pad, cover, and cover attaching screws.

(4) Position the speaker grill in the opening below the speaker, press in, and rotate the grill counterclockwise to engage the latching clips.

(5) Test the operation of the public address system to make sure that the speaker is operating at the correct volume level, (refer to Section 23-4-0, Adjustment/Test).





Public Address System Loudspeakers
Figure 201

PUBLIC ADDRESS SYSTEM CONTROL PANELS - MAINTENANCE PRACTICES

1. Removal/Installation Public Address Control Panels

   A. Equipment Required - None.

   B. Preparation. Open PA AMPL AC and DC circuit breakers on the main circuit breaker panel. Hang a warning sign on opened circuit breakers.

   C. Remove Pilot's Control Panel.

      (1) Release the Allen-head injector-extractor screw and lift out the panel.

      (2) Place cap or tape over electrical connector.

   D. Install Pilot's Control Panel.

      (1) Remove cap or tape from electrical connector.

      (2) Position the control panel in the pedestal. Make sure to engage the guide pins correctly.

      (3) Turn the injector screw in to secure the panel.

      (4) Test operation of the public address system, (refer to Section 23-4-0, Adjustment/Test).

   E. Remove Forward or Aft Stewardess Control Panel.

      (1) Release four Camloc fasteners and remove the panel.

      (2) Place cap or tape over electrical connector.

   F. Install Forward or Aft Stewardess Control Panel.

      (1) Remove cap or tape from connector.

      (2) Position the panel in the receptacle box and secure the four Camloc fasteners.

      (3) Test the operation of the public address system, (refer to Section 23-4-0, Adjustment/Test).

PUBLIC ADDRESS SYSTEM HANDSETS - MAINTENANCE PRACTICES

1. Removal/Installation Public Address System Handsets

   A. Equipment Required - None.

   B. Preparation. Open PA AMPL AC and DC circuit breakers. (Hang a warning sign on opened circuit breakers.)

   C. Remove Forward or Aft Stewardess Handset.

      (1) Lower the stewardess seat below the public address control panel and handset.

      (2) Disconnect the electrical connector from the receptacle in the upper inner edge of the seat frame. Place cap or tape over connector.

      (3) Withdraw the handset cord through the grommet in the bottom of the swivel door on which the handset hook switch assembly is mounted and remove the handset.

   D. Install Stewardess Handset.

      (1) Lower the stewardess seat in the entrance area.

      (2) Remove cap or tape from connector.

      (3) Pass the handset cord through the grommet in the bottom of the swivel door and through the structure below the door, and connect the electrical connector to the receptacle on the upper inner side of the seat frame. Hang the handset on the hook switch assembly.

      (4) Test the operation of the public address system from the stewardess position, (refer to Section 23-4-0, Adjustment/Test).

   E. Remove Pilot's Handset.

      (1) Disconnect the handset cord connector from the handset bracket receptacle at the bottom aft end of the pedestal, withdraw the coiled cord from the cylindrical guard, and remove the handset from the hook switch assembly.

      (2) Cap the receptacle or cover it with masking tape.

   F. Install Pilot's Handset.

      (1) Remove cap or tape from connector.

(2) Pass the coiled cord through the lower side of the cylindrical guard, connect the electrical connector, and hang the handset on the hook switch assembly.

(3) Check public address system operation, (refer to Section 23-4-0, Adjustment/Test).

PUBLIC ADDRESS SYSTEM AMPLIFIER - MAINTENANCE PRACTICES

1. Removal/Installation Public Address System Amplifier

A. Equipment Required - None.

B. Preparation.

(1) Open PA AMPL AC and DC circuit breakers on the main circuit breaker panel.

(2) Gain access to the amplifier on shelf C in the electronics compartment.

C. Remove Amplifier.

(1) Release the knurled thumb nut on the lower front panel of the amplifier.

(2) Withdraw the amplifier from the rack.

(3) Place cap or tape over electrical connector.

D. Install Amplifier.

(1) Remove cap or tape from connector.

(2) Position the amplifier on the rack and engage the guide pins at the rear.

(3) Secure the thumb nut on the bracket on the lower front panel.

(4) Test the operation of the public address sytem, (refer to Section 23-4-0, Adjustment/Test).

INTERPHONE SYSTEMS - DESCRIPTION AND OPERATION

1. General

The interphone system divides functionally into two systems: The flight interphone system and the service interphone system. The flight interphone system provides intercommunications among all members of the flight crew. The service interphone system enables service personnel to connect headset and microphones or headset-microphone combinations into jackboxes located in engine pylons, wheel wells, and other maintenance areas, and maintain intercommunications among themselves and with the flight compartment while the airplane is being serviced. Both interphone systems use the same audio amplifier. Figure 1 shows the locations of interphone equipment and stations.

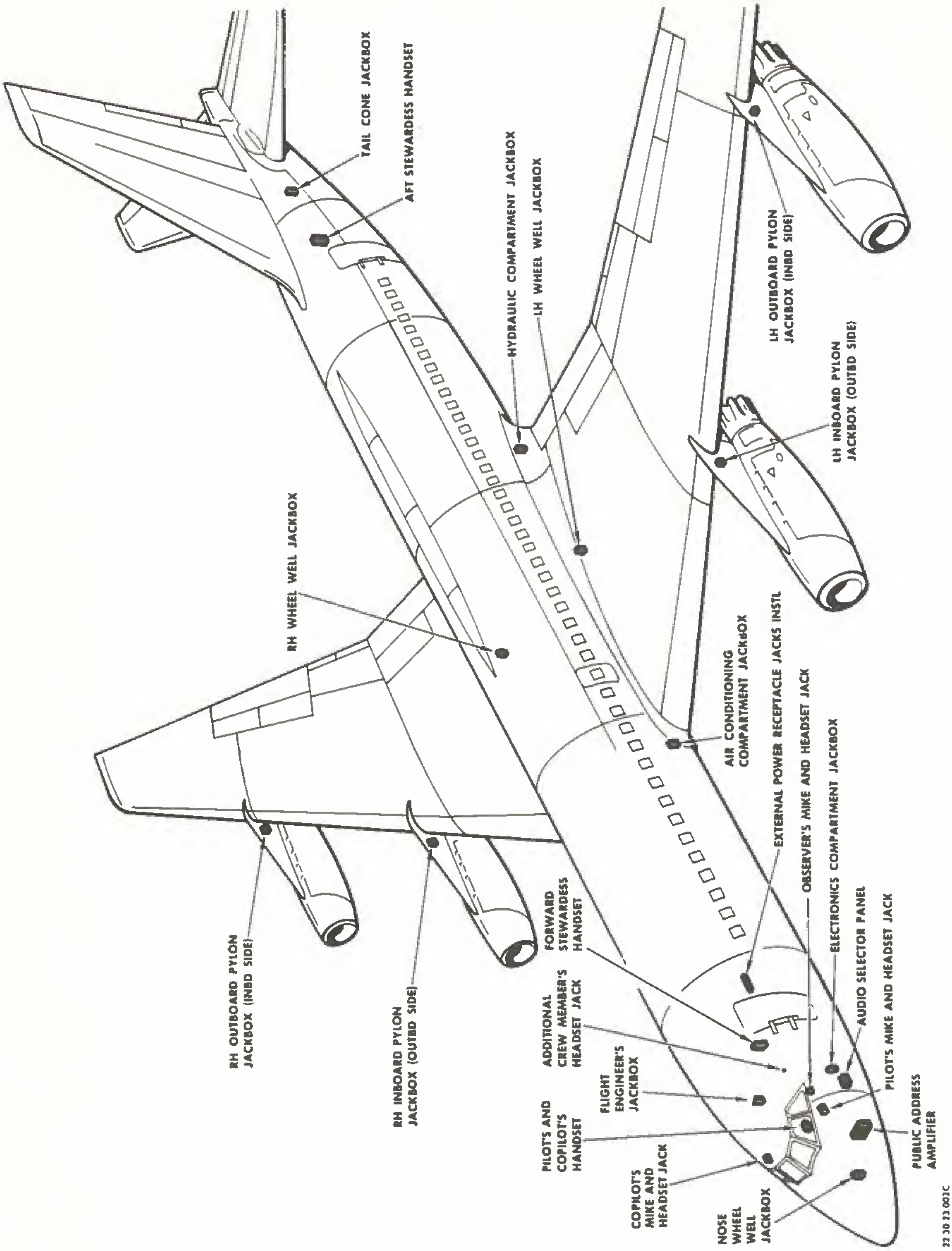
Microphone and headset audio of the interphone and radio communications systems, headset audio of the radio navigation systems, and test audio from the flight recorder system passes through the audio selector panel. Headset audio is selected by the toggle switches on the panel. Microphone audio for interphone and radio transmissions is selected by a five-position rotary switch. An audio selector panel is installed for the pilot, for the copilot, for the observer, and for the flight engineer; and a fifth panel is located in the electronics compartment for maintenance use.

A two-position toggle switch on the interphone microphone selector panel of the flight engineer interconnects all stations of flight and service interphone systems when the switch is actuated to ON position. When the selector switch is actuated to OFF position, only the interphone stations of the flight compartment, the passenger cabin, the electronics compartment and the nose wheel well jackbox remain connected into the interphone system. See Figure 2 for a block diagram of the flight and service interphone systems.

A chime in the flight compartment and two chimes in the cabin warn flight personnel of a call on the interphone system. Lights on the public address control panels in the cabin and in the flight compartment also illuminate to indicate the source of the call.

Stewardesses use the same handsets for interphone communications that they use for public address system announcements. Pilots can also use the handsets for interphone communications; but provisions are made for pilot and flight engineer intercommunications from smoke and oxygen masks.

A loudspeaker is installed for each pilot. When the flight compartment handset is removed from its hanger the pilots' loudspeakers are muted. Range filters can be switched into the audio outputs of ADF receivers.
A headset audio jack connected in parallel to the observer's audio is provided for the additional crew member's position on the left-hand aft bulkhead of the flight compartment.



Flight and Service Interphone Systems,
Locations Diagram
Figure 1

TEMPORARY REVISION NO. 23-1.

Insert facing 23-5-0, Page 2, dated May 15/61.

Page 2, just above the callout for the nose wheel well jackbox, delete the callout "PUBLIC ADDRESS AMPLIFIER" and add "INTERPHONE AMPLIFIER".

2. Power Requirements

Dc power at 28 volts is used by the interphone system. Each audio selector panel drains 0.1 ampere, and the Collins 346A-1 interphone amplifier unit drains 0.41 ampere. Total current drain of the interphone system is, therefore, 0.91 ampere. This constitutes a total power input requirement of about 30 watts. Power is taken from the emergency dc radio bus.

3. Circuit Protection

The two dc power input circuits to the interphone system are protected by 5-ampere circuit breakers. A 0.75-ampere fuse in the fuse holder on the front panel of the Collins 346A-1 amplifier unit protects the 27.5-volt input circuit to the unit.

4. Audio Selector Panels

The audio frequency of the radio, interphone, and flight recorder systems goes through the audio selector panel. Headset audio is selected by toggle switches and microphone audio is selected by a rotary switch. Flight recorder test audio is heard with the INT toggle switch actuated, when the flight recorder test on the pilot's console is also actuated. The audio selector panel contains an isolating amplifier that permits the selection of one or more audio sources at any panel without inteferring with the selection made at any of the other three panels. A volume control is concentric with the microphone selector switch. Figure 3, shows an illustration of the audio selector panel.

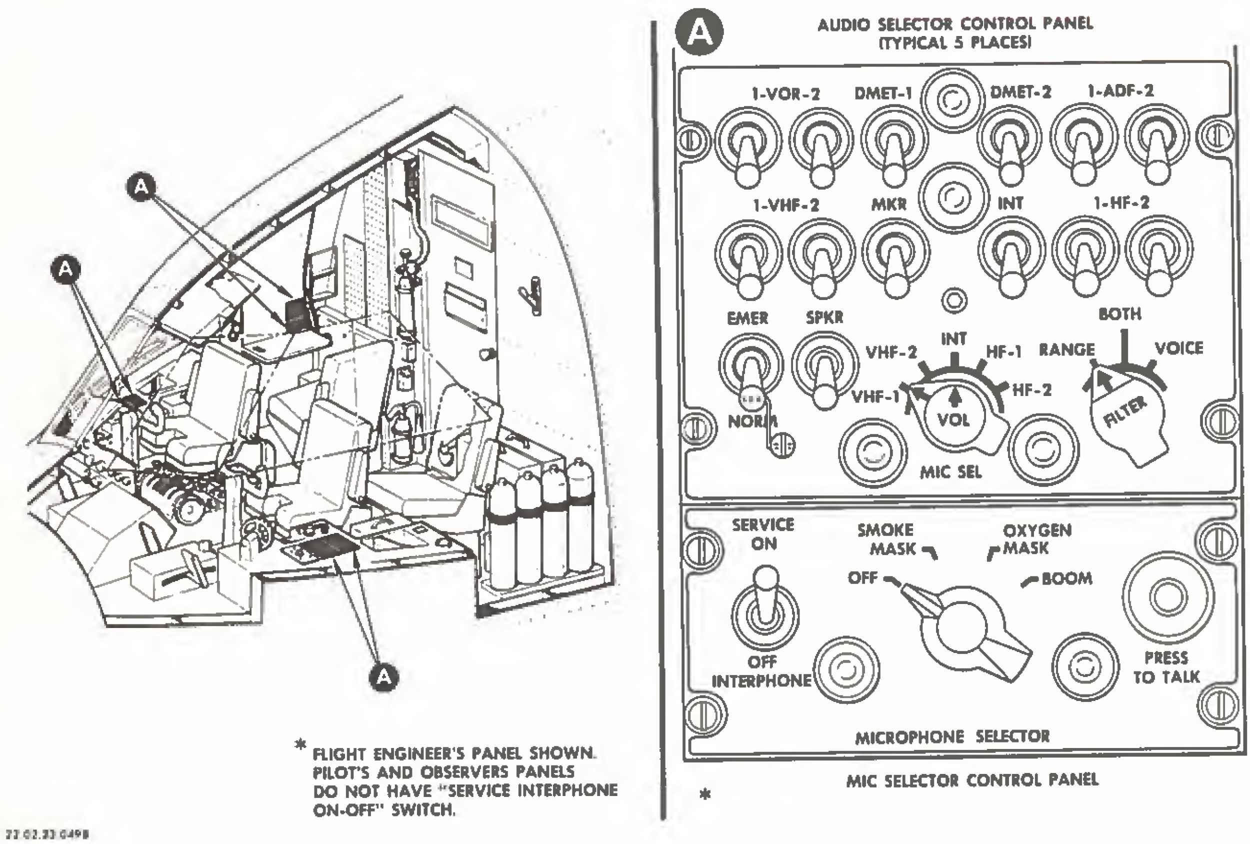
If the isolating amplifier fails, audio frequency can be heard without amplification by breaking the safety wire of the EMER-NORM toggle switch and actuating the toggle switch to EMER position. With this switch in emergency position, the operator should select only one audio source at a time.

The three-position, rotary, FILTER switch on the audio selector panel selects a range filter in the audio junction box.

The SPKR toggle switch of the pilot's and copilot's audio selector panel switches audio frequency to the loudspeaker at the side of the overhead switch panel, enabling the pilot to communicate on interphone or on radio without wearing a headset. The corresponding speaker is muted when the pilot or copilot keys his microphone.

5. Microphone Selector Panels (see Figure 3)

Microphone selector panels enable pilot, copilot, observer, and flight engineer to switch smoke mask, oxygen mask, and boom mask microphones into the interphone system.



Audio Selector Panel
Figure 3

A. Pilot's Microphone Selector Panel carries a four-position rotary microphone selector switch and two panel lights. The panel is installed with four Camloc fasteners. Electrical connections are made through receptacles on the back of the panel.

Switch positions are marked OFF, SMOKE MASK, OXYGEN MASK, and BOOM from left to right. The switch enables the pilot to switch any microphone he may be using into the interphone system.

B. Copilot's and Observer's Microphone Selector Panels are identical with the pilot's panel. A push-to-talk switch for the observer is installed on the aft end of the pilot's console.

C. Flight Engineer's Microphone Selector Panel carries a microphone selector switch, a push-to-talk switch, and a SERVICE INTERPHONE switch. In ON position of the service interphone switch, all stations of the interphone system are interconnected. In OFF position only the interphone stations of the flight compartment, the passenger cabin, the electronics compartment, and the nose wheel well remain connected into the interphone system. The microphone selector switch has the same position markings as the pilot's and copilot's control panels. The flight engineer must keep the press-to-talk switch depressed while talking on interphone.

D. Cabin Interphone Control Panels. Forward and aft positions of the cabin public address control panels also serve as interphone control panels.

6. Amplifier

A Collins 346A-1 interphone amplifier is installed on the upper left-hand shelf in the electronics compartment. This unit consists of two amplifier modules for the pilot's and copilot's speakers and an amplifier module for the interphone microphone audio.

The unit is housed in a metal case that is secured to the mounting rack by a single winged nut. The side and top of the case are perforated for ventilation. The front panel is equipped with a handle. A fuse holder on the front panel contains an 0.75-ampere fuse that protects the 28-volt dc power input circuit. Electrical connections are made through a receptacle at the rear of the mounting rack.

The transistorized amplifier modules in the unit are constructed on printed circuit boards. Two amplifiers supply audio power for the pilot's and copilot's interphone speakers, and the third amplifies interphone microphone audio from all the flight and service interphone stations and jackboxes. Amplified interphone output is supplied through the audio junction box to all flight interphone stations, and to all service interphone jackboxes.

7. Loudspeakers

Pilot's and copilot's interphone speakers are installed on the right- and left-hand sides of the overhead switch panel just aft of the map reading lights. The speakers are 4-inch Quam speakers, model 4A07Z45. Plastic grills over the speakers are held by two screws. The speakers are easily accessible for servicing or replacement after the grills are removed. The speakers are installed at angles that make them directional toward the sides on which they are installed.

8. Microphones

Oxygen mask and smoke mask microphones and hand-held microphones with push-to-talk switches are provided. Jacks for these microphones are located on the consoles adjacent to the pilots, and jacks are provided for the flight engineer. A boom microphone may also be used. RS-38 type microphones are used.

9. Push-to-Talk Microphone Switch

The pilot and copilot must depress and hold thumb-operated switches on the side of the outboard grip of the control column while using the microphone for radio or interphone communications. The flight engineer must depress and hold the push-to-talk switch located on his microphone selector panel. The observer must depress a push-to-talk switch on aft end of the pilot's console while using the microphone. Stewardess handsets are on public address if the amber light of the PUSH-PA switch assembly on the control panels is illuminated, and on interphone if the amber light is extinguished.

10. Jackboxes

All jackboxes have three jacks: for headset, for microphone, and for handset. The nose wheel well jackbox and the electronics compartment jackbox have push-button switches which enable station personnel to call the flight compartment. Electrical connections are made to the jackboxes by connector plugs. Each jackbox is held to airplane structure by two captive, Phillips-head screws. Spring-loaded dust caps protect the jacks when they are not in use.

INTERPHONE SYSTEMS - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. FLIGHT AND SERVICE INTERPHONE SYSTEM INOPERATIVE	
A. Interphone amplifier faulty.	Make sure that both AUDIO SELECT circuit breakers are closed, and that the SERVICE INTERPHONE switch on the flight engineer's interphone microphone selector panel is actuated to ON position. Test the system from several interphone positions, including the flight compartment. If all stations are dead, replace the interphone amplifier.
2. NO MICROPHONE AUDIO FROM ONE INTERPHONE POSITION	
A. Microphone faulty.	Plug in a known good microphone and retest.
B. Microphone or handset jack faulty.	Visually inspect the jack for condition and electrical connections. Replace the jack or jackbox if the jack is defective.
C. Wiring faulty.	Test for voltage at the microphone connection of the handset or microphone jack. Voltage should be less than 28-volts dc. If no voltage, make continuity test of wire segments from the microphone jack to pin No. 7 of the interphone amplifier on shelf C in the electronics compartment. Replace or repair faulty wire.
3. NO HEADSET AUDIO AT ONE INTERPHONE POSITION	
A. Faulty headset.	Plug in a known good headset or handset and retest.
B. Headset or handset jack faulty.	Visually inspect the jack for condition and electrical connections. Replace jack or jackbox if the jack is defective.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
3. NO HEADSET AUDIO AT ONE INTERPHONE POSITION (CONT)	
C. Wiring faulty.	Make continuity and short circuit tests of wiring from the headset connection of the handset or headset jack to pin No. 21 of the interphone amplifier. Repair or replace open-circuited or short-circuited wiring.
4. ALL SERVICE INTERPHONE POSITIONS EXCEPT NOSE WHEEL WELL INOPERATIVE	
A. Flight engineer's interphone selector switch faulty.	Remove the flight engineer's interphone microphone selector switch panel. Actuate the SERVICE INTERPHONE selector switch to ON position. Test for continuity between pins AA and BB and between CC and DD. If no continuity, install a known good selector panel. If switch is normal proceed to the next test.
B. Wiring faulty.	Test for voltage of less than 28-volts dc at pin AA of the receptacle from which the selector panel was removed. If no voltage, test for open wire segment between pin AA and pin No. 7 of the interphone amplifier on shelf C in the electronics compartment. Also test for continuity in the headset audio line between pin CC and pin No. 21 of the interphone amplifier. Repair or replace shorted or open-circuited wiring.

INTERPHONE SYSTEMS - MAINTENANCE PRACTICES

1. Adjustment/Test Interphone Systems

   A. Equipment Required.

      (1) External ac power unit.

      (2) Headsets and microphones.

   B. Preparation.

      (1) Connect the ground power unit and switch on ac and dc power.

      (2) Close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT AND FLT ENGR DC circuit breakers on the main circuit breaker panel.

   C. Test Interphone Systems.

      (1) Actuate the pilot's, copilot's, and flight engineer's audio selector panel toggle switches and microphone selector switches to INT position. Set the volume control on each panel about half-way up.

      (2) Plug a headset into the headset jacks, and microphones into oxygen mask jacks. Select OXYGEN MASK on the microphone selector panels.

      (3) Press the PRESS-TO-TALK switch on the pilot's control column and talk into the pilot's oxygen mask microphone. There should be adequate sidetone in the pilot's headset and the voice should be audible at the other headset positions.

      (4) In a similar manner test operation from the copilot's, observer's, and flight engineer's positions.

      (5) Plug the smoke mask microphones into SMOKE MASK microphone jacks and select SMOKE MASK on the microphone selector panels. Test operation at all positions. Plug the boom microphones into BOOM microphone jacks and test operation, using the press-to-talk switches on the control columns.

      (6) Check that the volume controls on the audio selector panels control audio volume levels.

      (7) If possible, check radio receiver audio through the audio selector panel by actuating the toggle switches for the various radio systems.

      (8) Plug handsets into stewardesses position in the cabin and test interphone operation between flight compartment and cabin.

(9) Plug a handset into the nose wheel well jackbox and test communications with the pilot's position.

(10) Actuate the SERVICE INTERPHONE SWITCH on the flight engineer's microphone selector panel to ON position.

(11) Plug a handset into the external power receptacle jackbox and test communications to the pilot's position.

(12) Similarly test communications from the two outboard pylon jackboxes, from the two inboard pylon refueling panels, from the hydraulic compartment jackbox, from the air-conditioning compartment jackbox, and from the tail cone jackbox.

(13) While testing from the tail cone position, actuate the flight engineer's SERVICE INTERPHONE switch to OFF position and note that communications to the pilot's position are interrupted.

(14) If tests are not satisfactory at any point, trouble shoot the system.

AUDIO SELECTOR PANEL - MAINTENANCE PRACTICES

1. Removal/Installation Audio Selector Panel.

   A. Equipment Required - None.

   B. Preparation. Open AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers. (Hang warning sign on opened circuit breakers.)

   C. Remove Audio Selector Panel.

      (1) Unscrew the captive, Allen-head, injector-extractor screw near the center of the panel and lift out the panel.

      (2) Put cap or masking tape over the receptacle to protect it.

   D. Install Audio Selector Panel.

      (1) Remove cap or masking tape from receptacle.

      (2) Position the selector panel and engage the guide pins.

      (3) Pull the panel tightly into place by the Allen-head, injector-extractor screw.

      (4) Close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers and remove warning sign.

      (5) Test system operation, (refer to Section 23-5-0, Adjustment/Test).

MICROPHONE SELECTOR PANEL - MAINTENANCE PRACTICES

1. Removal/Installation Microphone Selector Panel

   A. Equipment Required - None.

   B. Preparation. Open AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers. (Hang warning sign on opened circuit breakers.)

   C. Remove microphone selector panel.

      (1) Release four Camloc fasteners and withdraw the microphone panel for access to the connector plug. The cables at all three positions of the microphone selector panels are long enough to permit access to the receptacles.

      (2) Unscrew two screws from the receptacle to allow plug and receptacle to separate. Cap the plug and the receptacle or cover them with masking tape to protect them.

   D. Install microphone selector panel.

      (1) Remove cap or tape from receptacles.

      (2) Pull out the microphone selector plug from the console or from the flight engineer's panel, connect the plug to the receptacle on the microphone selector panel, and secure the plug by two screws.

      (3) Position the selector panel in the space provided and secure it by four Camloc fasteners.

      (4) Close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENG DC circuit breakers and remove warning sign.

      (5) Test system operation, (refer to Section 23-5-0, Adjustment/Test).

INTERPHONE AMPLIFIER - MAINTENANCE PRACTICES

1. Removal/Installation Interphone Amplifier (refer to Section 23-4-0. Figure 201)

   A. Equipment Required - None.

   B. Preparation. Open AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers. (Hang warning signs on open circuit breakers.)

   C. Remove Interphone Amplifier.

      (1) Gain access to the interphone amplifier on shelf C in the electronics compartment.

      (2) Release the knurled thumb nut at the base of the amplifier and withdraw the amplifier from the rack. Cover the receptacle with a cap or masking tape for protection.

   D. Install Interphone Amplifier.

      (1) Remove cap or tape from receptacle.

      (2) Position the interphone amplifier on the rack engage the guide pins, and push the amplifier back into position.

      (3) Secure the thumb nut at the base of the amplifier.

      (4) Close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers and remove warning signs.

      (5) Test system operation (refer to Section 23-5-0, Adjustment/Test)

INTERPHONE JACKBOX - MAINTENANCE PRACTICES

1. Removal/Installation Interphone Jackbox (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers. (Hang warning sign on opened circuit breakers.)

      (2) Gain access to compartment or area.

   C. Remove Interphone Jackbox.

      (1) Disconnect and cap or tape the electrical connector.

      (2) Unscrew two Phillips-head captive screws and remove jackbox. (Bag and tag screws for installation.)

   D. Install Interphone Jackbox.

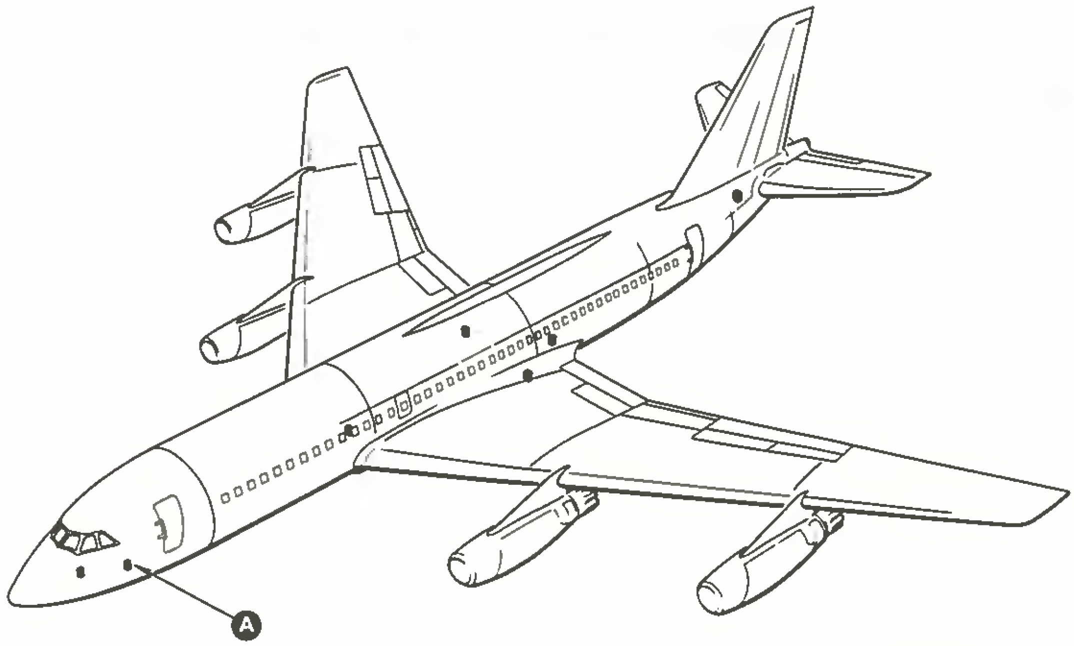
      (1) Remove cap or tape from connector.

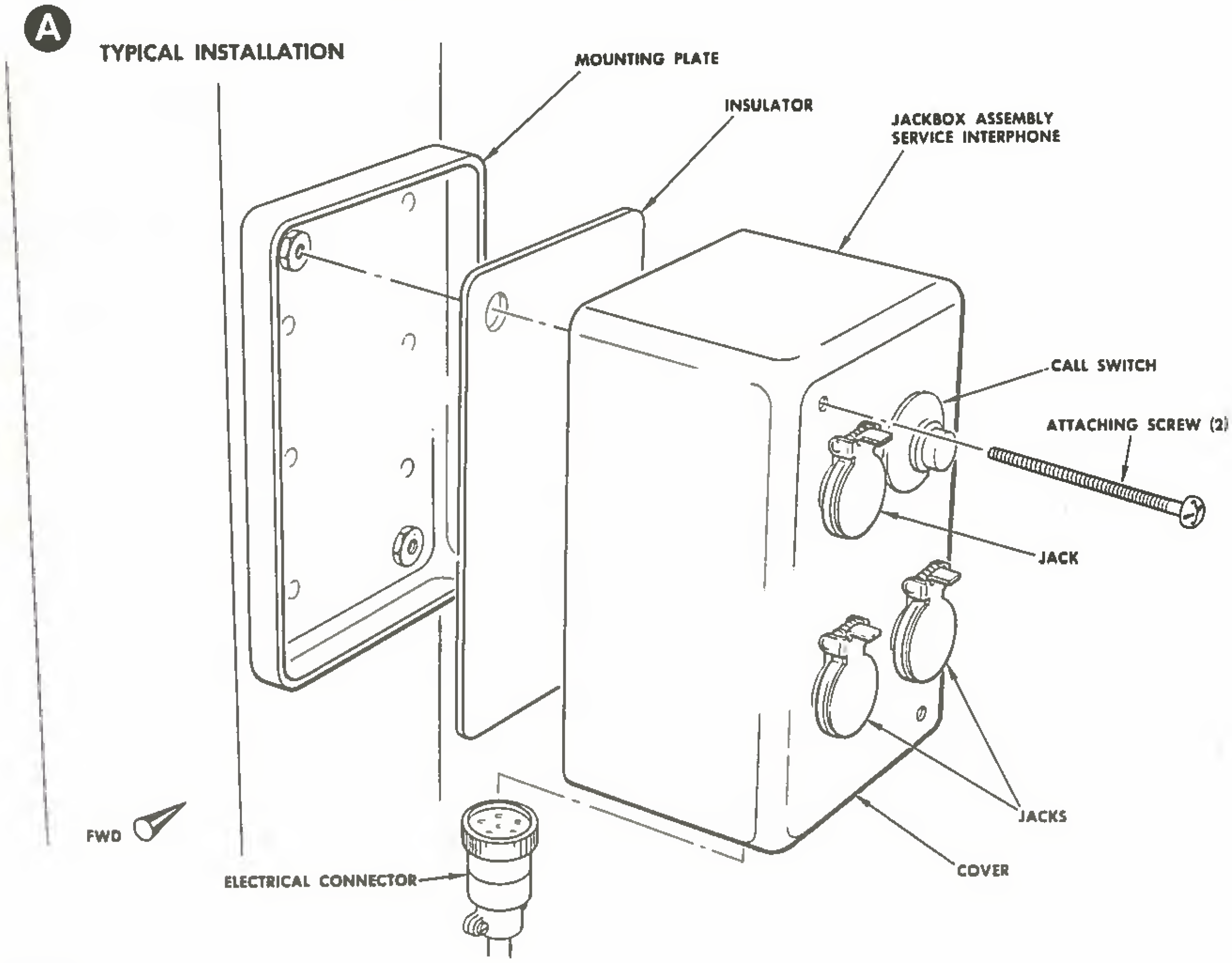
      (2) Position interphone jackbox and secure two captive screws.

      (3) Connect the electrical connector.

      (4) Close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers and remove warning sign.

      (5) Test system operation, (refer to Section 23-5-0, Adjustment/Test).





Interphone Jackbox Installation, Typical
Figure 201

REFUELING PANEL INTERPHONE JACKS - MAINTENANCE PRACTICES

1. Removal/Installation Refueling Panel Interphone Jacks (see Figure 201)

   A. Equipment Required - None.

   B. Preparation. Open AUDIO SELECT - PILOT RACK DC and COPILOT AND FLT ENGR DC circuit breakers. (Hang warning signs on open circuit breakers.)

   C. Remove Refueling Panel Interphone Jacks.

      (1) Release nuts holding refueling panel and tip panel forward for access to the three interphone jacks. (Bag and tag screws for installation.)

      (2) Remove screws to disconnect wires from jacks and attach identification tags to wires for installation. (Bag and tag screws for installation.)

      (3) Remove the hexagonal nut of the jack on the face of the refueling panel and remove jack.

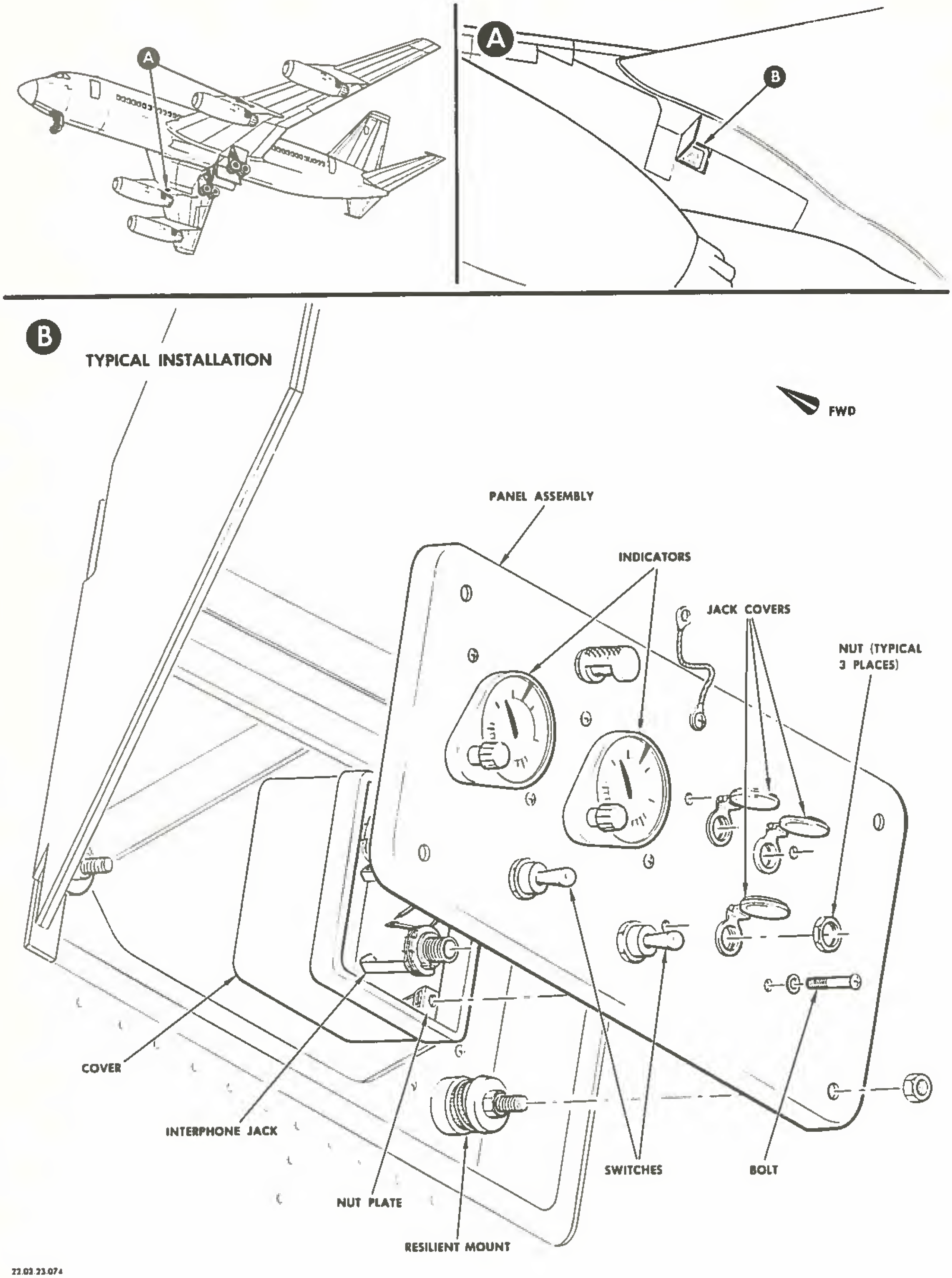
   D. Install Refueling Panel Interphone Jacks.

      (1) Position the jack in its correct position in the refueling panel and secure in place with a hexagonal nut on the face side of the panel.

      (2) Connect the electrical wiring to the jack in accordance with the identification tags.

      (3) Close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT AND FLT ENGR DC circuit breakers and remove warning signs.

      (4) Test system operation, (refer to Section 23-5-0, Adjustment/Test).



Refueling Panel Interphone Jacks Installation
Figure 201

CONSOLE HEADSET AND BOOM MICROPHONE JACKS - MAINTENANCE PRACTICES

1. Removal/Installation Console Headset and Boom Microphone Jacks (see Figure 201

   A. Equipment Required - None.

   B. Preparation.

      (1) Open AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT AND FLT ENGR DC circuit breakers. (Hang warning signs on open circuit breakers.)

      (2) Remove six screws securing panel on rear of flight kit storage space, and remove panel for access to rear of jacks.

   C. Remove Console Headset and Boom Microphone Jacks.

      (1) Remove hexagonal nut from headset jack or two screws from boom microphone jack and withdraw the jack for access to wiring.

      (2) Disconnect wires and remove jack. Attach identification tags to wires for installation.

   D. Install Console Headset and Boom Microphone Jacks.

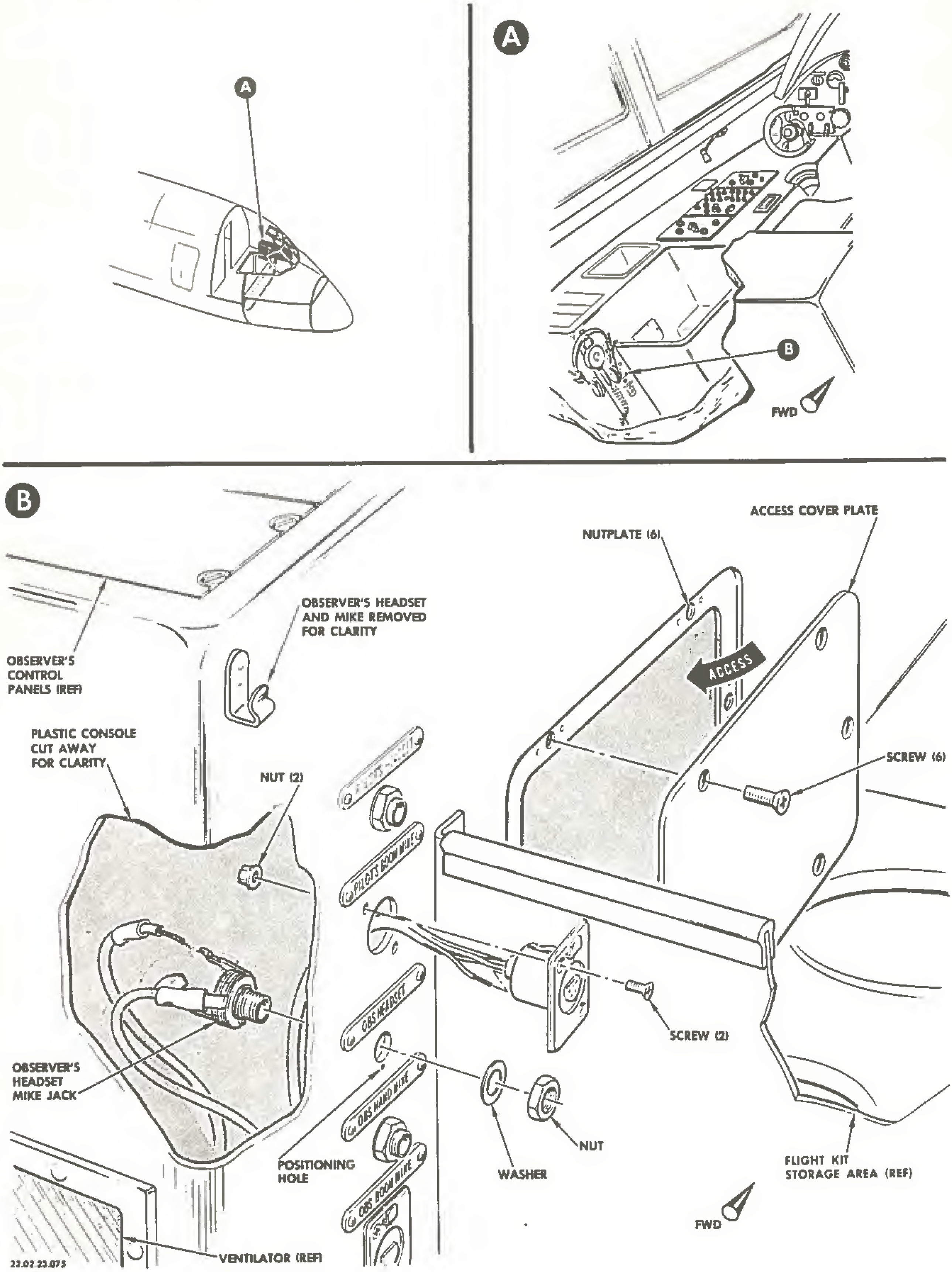
      (1) Connect wiring to jack in accordance with identification tags.

      (2) Position jack in opening provided on console. Secure headset jack by hexagonal nut or the boom microphone jack by two screws.

      (3) Replace panel in flight kit storage area and secure with six screws.

      (4) Close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT AND FLT ENGR DC circuit breakers and remove warning signs.

      (5) Test system operation, (refer to Section 23-5-0, Adjustment/Test).



Console Headset and Boom Microphone
Jacks Installation
Figure 201

FLIGHT ENGINEER'S INTERPHONE JACKS - MAINTENANCE PRACTICES

1. Removal/Installation Flight Engineer's Interphone Jacks (see Figure 201)

   A. Equipment Required - None.

   B. Preparation. Open AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT AND FLT ENGR DC circuit breakers. (Hang warning signs on open circuit breakers.)

   C. Remove Flight Engineer's Interphone Jacks.

      (1) Remove screws holding the bracket for flight engineer's interphone jacks. (Bag and tag screws for installation.)

      NOTE: The bracket is located on the aft side of flight engineer's control panel near table top level.

      (2) Disconnect wires from jacks and remove jacks. Attach identification tags to wires for installation.

   D. Install Flight Engineer's Interphone Jacks.

      (1) Install jacks to mounting bracket.

      (2) Secure wires to jacks in accordance with identification tags.

      (3) Secure mounting bracket to aft side of flight engineer's control panel.

      (4) Close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT AND FLT ENGR DC circuit breakers and remove warning signs.

      (5) Test system operation, (refer to Section 23-5-0, Adjustment/Test).

2. Removal/Installation Flight Engineer's Smoke Mask and Oxygen Mask Interphone Jacks

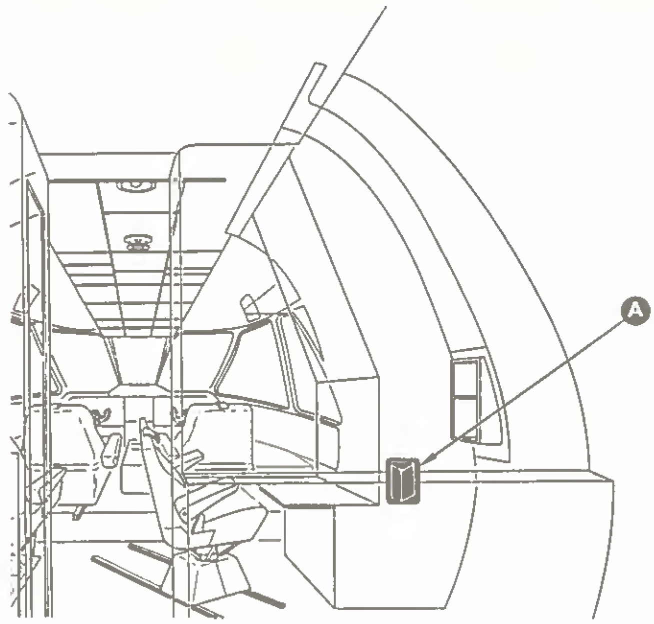
   A. Equipment Required - None.

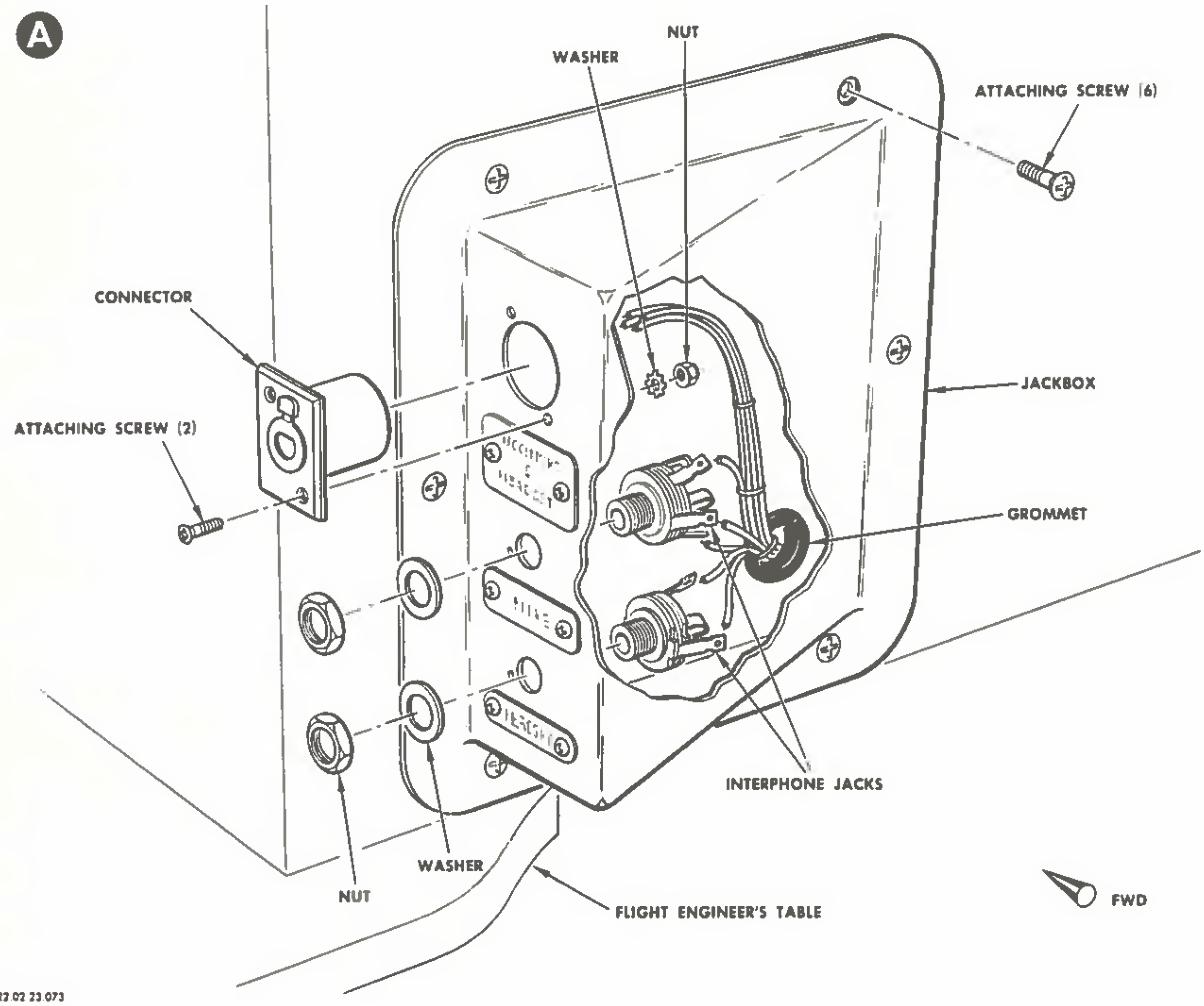
   B. Preparation. Open AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT AND FLT ENGR DC circuit breakers.

   C. Remove Flight Engineer's Oxygen Mask Interphone Jack.

      (1) Gain access to rear of smoke mask and oxygen mask box, refer to Chapter 25, EQUIPMENT/FURNISHINGS.

      (2) Disconnect wires from jack terminals. Attach identification tags to wires for installation.





Flight Engineer's Interphone Jacks Installation
Figure 201

(3) Remove locknut from jack and remove jack.

D. Install Flight Engineer's Oxygen Mask Interphone Jack.

(1) Place jack in smoke mask and oxygen mask box and secure with lock-nut.

(2) Connect wires to jack terminals in accordance with identification tags.

(3) Replace smoke mask and oxygen mask box, refer to Chapter 25, EQUIPMENT/FURNISHINGS.

E. Remove Flight Engineer's Smoke Mask Interphone Receptacle.

(1) Gain access to rear of smoke mask and oxygen mask box, refer to Chapter 25, EQUIPMENT/FURNISHINGS.

(2) Disconnect wires from receptacle terminals. Attach identification tags to wires for installation.

(3) Remove screws and nuts securing receptacle to box and remove receptacle.

F. Install Flight Engineer's Smoke Mask Interphone Receptacle.

(1) Replace smoke mask receptacle in box and secure with two screws and nuts.

(2) Connect wires to receptacle terminals in accordance with identification tags.

(3) Replace smoke mask and oxygen mask box, refer to Chapter 25, EQUIPMENT/FURNISHINGS.

(4) Close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT AND FLT ENGR DC circuit breakers.

(5) Test system operation, (refer to Section 23-5-0, Adjustment/Test).

OUTBOARD PYLON INTERPHONE JACKS - MAINTENANCE PRACTICES

1. Removal/Installation Outboard Pylon Interphone Jacks (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers. (Hang warning signs on open circuit breakers.)

      (2) Gain access to interphone jacks (right- or left-hand outboard pylons).

   C. Remove Outboard Pylon Interphone Jacks.

      (1) Remove the four screws securing front panel to jackbox. Pull panel out to gain access to terminals of jacks. (Bag and tag screws for installation.)

      (2) Remove hexnut securing jack to panel.

      (3) Remove screws and wires from jack terminals. Tag wires for installation.

   D. Install Outboard Pylon Interphone Jacks.

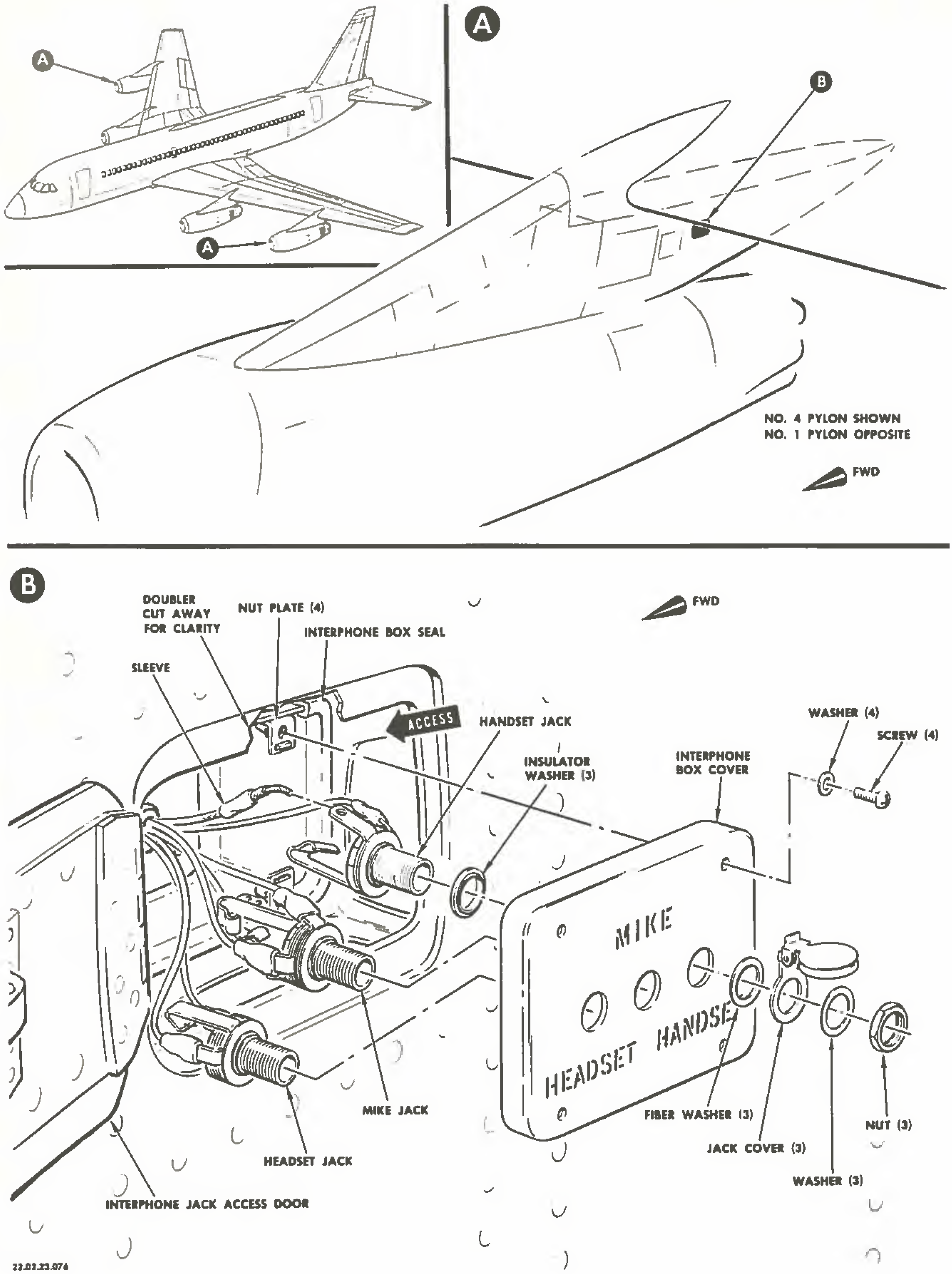
      (1) Install jack in front panel of jackbox and secure with hexnut.

      (2) Attach wires to jack terminals according to tags affixed in Removal step C. (3).

      (3) Position panel over mounting holes and secure with screws previously removed.

      (4) Remove warning signs and close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers.

      (5) Test system operation, (refer to Section 23-5-0, Adjustment/Test).



Outboard Pylon Interphone Jacks Installation
Figure 201

PILOTS' CONTROL WHEEL MICROPHONE SWITCH - MAINTENANCE PRACTICES

1. Removal/Installation Pilots' Control Wheel Microphone Switch (see Figure 201)

   A. Equipment Required - None.

   B. Remove Pilots' Control Wheel Microphone Switch.

      (1) Open AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers. (Hang warning signs on open circuit breakers.)

      (2) Remove snap ring securing switch to control wheel.

      (3) Pull switch out to gain access to terminals.

      (4) Remove screws and washers securing wires to switch terminals. Attach identification tags to wires for installation.

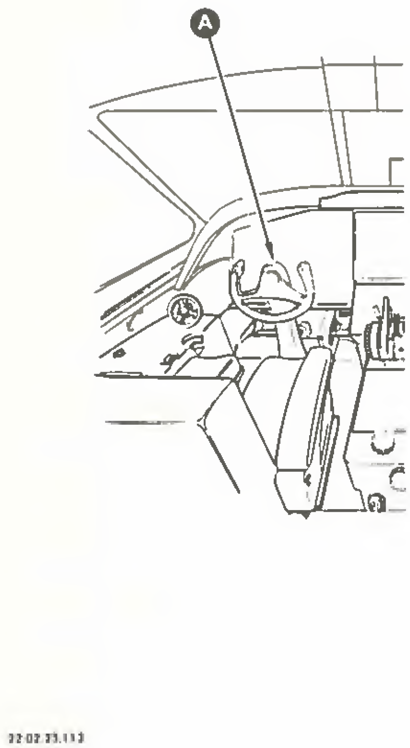
   C. Install Pilots' Control Wheel Microphone Switch.

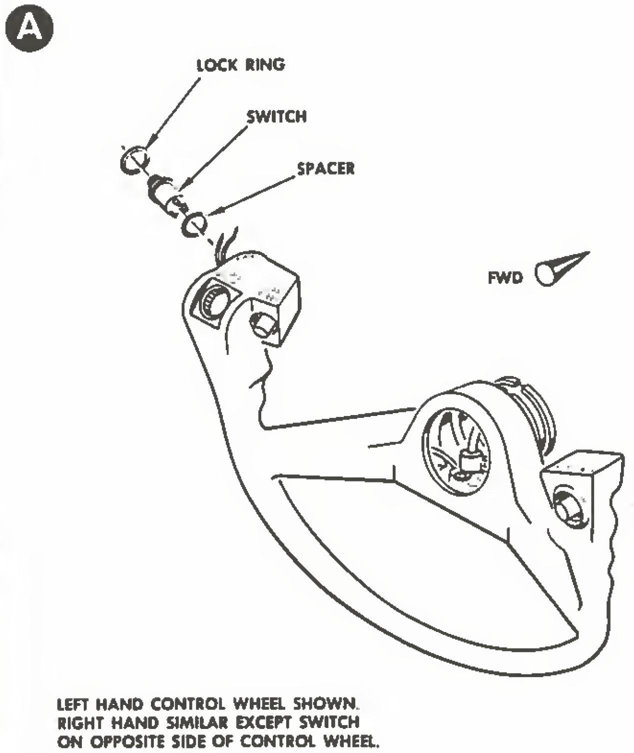
      (1) Connect wires to switch terminals with screws and washers.

      (2) Position switch in control wheel and secure with snap ring.

      (3) Close AUDIO SELECT - PILOT & RADIO RACK DC and COPILOT and FLT ENGR DC circuit breakers.

      (4) Test system operation, (refer to Section 23-5-0, Adjustment/Test).





Pilots' Control Wheel Microphone
Switch Installation
Figure 201

TAPE REPRODUCER SYSTEM - DESCRIPTION AND OPERATION

1. General

The tape reproducer system consists of a Gables model G-825 tape transport mechanism, a power supply, a preamplifier, and a relay. This equipment is housed in a full length 1/2-ATR enclosure and is installed on shelf C in the electronics compartment. Figure 1 shows a block diagram of the system.

The forward stewardess public address control panel switches the tape reproducer on and off and controls the listening level over the cabin loudspeaker system. Seven inch diameter reels of 1/4-inch tape provide four hours of music. The tape automatically reverses direction at the end of each tape.

The dual half-track tape transport mechanism is driven by a reversible dc motor. Tape guides, a magnetic clutch, and tape take-up provisions give reliable operation. The front panel of the reproducer has an on-off switch, a local volume control, tone controls, and a handle. Tone control adjustments of the system must be made at the unit.

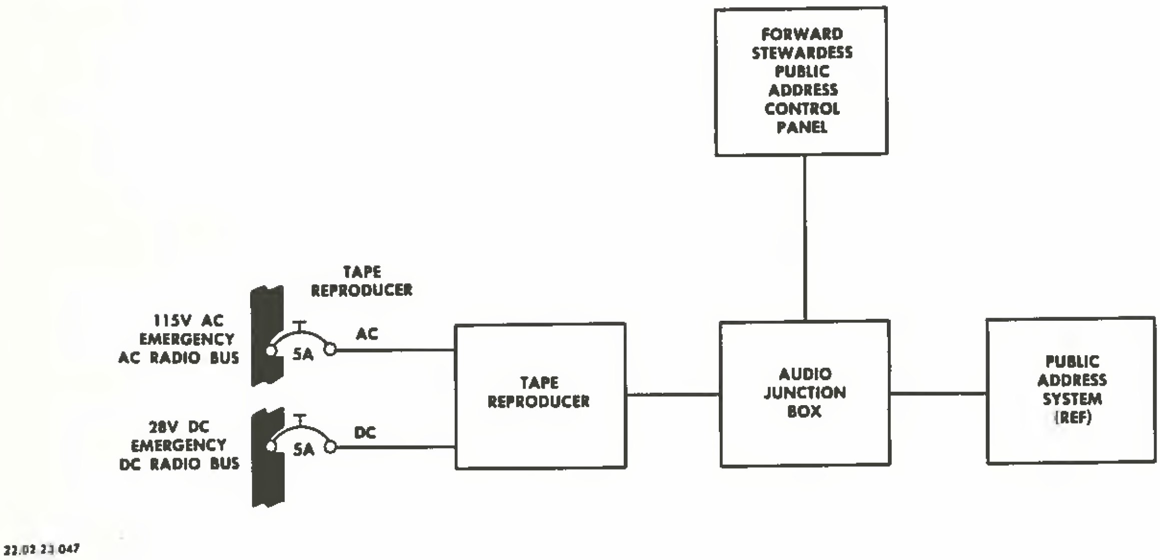
Electrical connections of the tape reproducer are made through a receptacle at the rear of the case. The case is secured to the mounting base by two knurled nuts.

2. Power requirements

The G-825 tape reproducer drains one ampere of current at 115-volts ac from the emergency radio ac bus, and one-half ampere at 28-volts dc from the emergency dc radio bus.

3. Circuit protection

Each electrical power circuit of the tape reproducer system is protected by a 5-ampere circuit breaker.



Tape Reproducer System, Block Diagram
Figure 1

TAPE REPRODUCER SYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. TAPE REPRODUCER SYSTEM DOES NOT OPERATE	
A. Circuit breakers of tape reproducer or public address system open.	Check TAPE REPRODUCER - AC and DC and PA AMPL AC and DC circuit breakers, if open - close.
B. No ac or dc power.	Check airplane power system, (refer to Chapter 24, ELECTRICAL POWER).
C. Tape reproducer faulty.	Replace unit with one of known quality, if operation is good send faulty unit to overhaul.
D. Forward stewardess PA control panel faulty.	Replace forward stewardess PA control panel with one of known quality and recheck operation. If operation is good, send faulty unit to overhaul.
E. Associated wiring faulty.	Check continuity of wiring between circuit breakers and unit, and PA system and reproducer unit. If no continuity repair or replace wiring as necessary.
F. Tape broken or fouled.	Remove reproducer unit from shelf and open cover to check tape, if broken or fouled replace or straighten tape. Check system operation.
2. TAPE REPRODUCTION DISTORTED	
A. Tape damaged.	Remove reproducer unit from shelf and open cover to check tape, if broken or fouled replace or straighten tape. Check system operation.
B. Public address system faulty.	Trouble shoot public address system, (refer to Section 23-4-0, Trouble Shooting).
C. Forward stewardess PA control panel faulty.	Replace forward stewardess PA control panel with one of known quality and recheck operation. If operation is good, send faulty unit to overhaul.

TAPE REPRODUCER SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Tape Reproducer System

   A. Equipment required - External ac power unit.

   B. Preparation.

      (1) Connect the power supply and switch on power.

      (2) Close TAPE REPRODUCER - AC and DC, and PA AMPL - AC and DC circuit breakers on the main circuit breaker panel.

   C. Test Tape Reproducer System.

      (1) On the forward stewardess public address control panel, actuate the MUSIC toggle switch to ON position.

      (2) Rotate the MUSIC volume control clockwise to increase the volume. Note that the quality of reproduction is satisfactory. Check each speaker for adequate output.

      (3) Make sure that the pilot's and the two stewardess handsets mute the music when an announcement is made over the public address system.

      (4) If operation is not satisfactory, troubleshoot the system.

TAPE REPRODUCER - MAINTENANCE PRACTICES

1. Removal/Installation Tape Reproducer (see Figure 201)

A. Equipment required - None.

B. Preparation. Open TAPE REPRODUCER AC and DC circuit breakers. (Hang warning signs on open circuit breakers.)

C. Remove Tape Reproducer.

(1) Unscrew the knurled nuts and withdraw the tape reproducer from the rack.

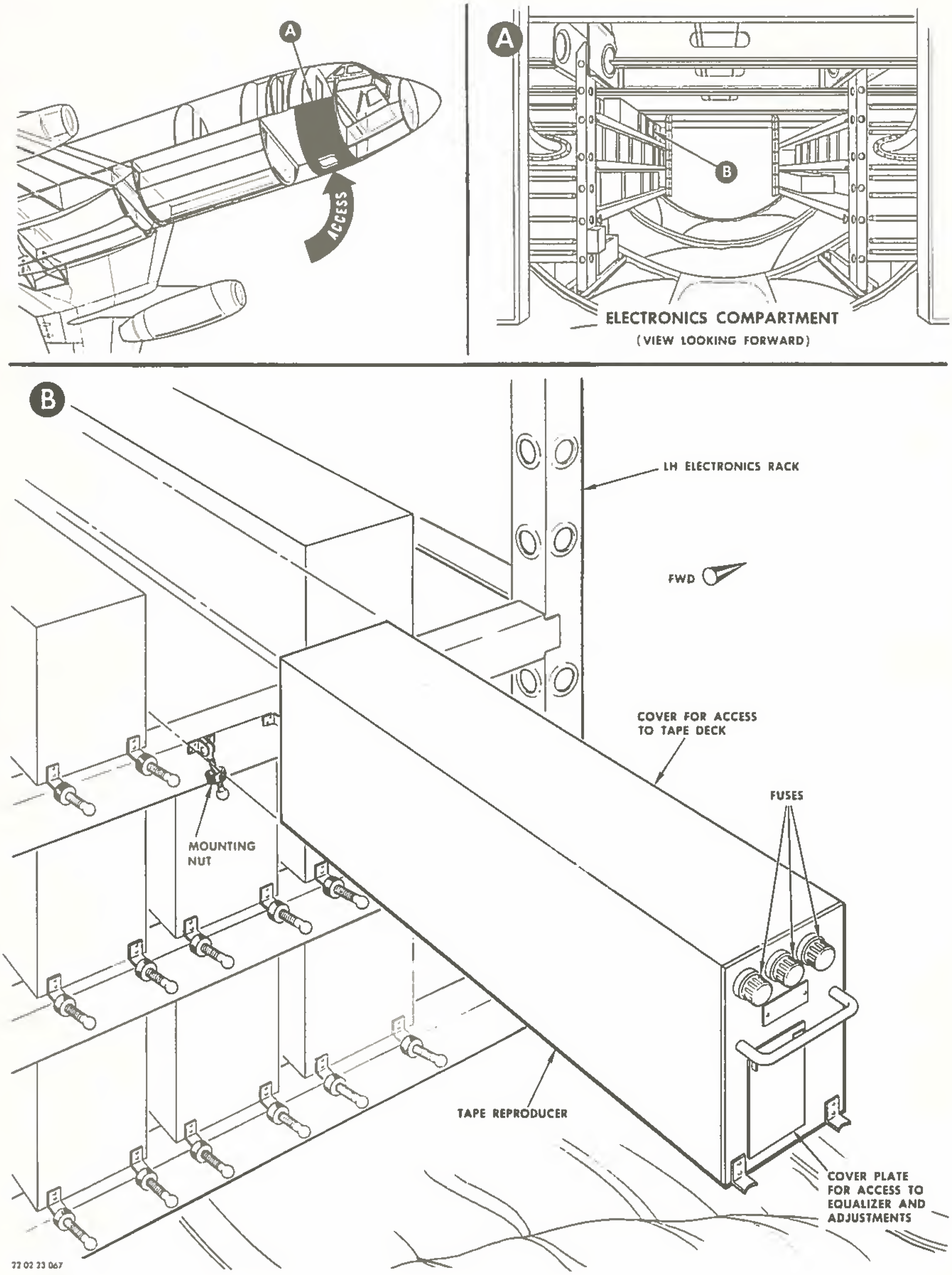
(2) Remove the side cover of the unit and wind the tape onto one reel. Retain the reel for installation in the replacement tape reproducer.

D. Install Tape Reproducer.

(1) Secure the tape end in the empty reel of the replacement tape reproducer and install the full reel in the reproducer.

(2) Slide the tape reproducer into the rack and tighten the knurled nuts to secure the unit in place.

(3) Test operation of the tape reproducer system, (refer to Section 23-6-0, Adjustment/Test).



Tape Reproducer Installation
Figure 201

PRE-RECORDED TAPE - MAINTENANCE PRACTICES

1. Removal/Installation Pre-recorded Tape (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open TAPE REPRODUCER AC and DC circuit breakers. Hang warning signs on open circuit breakers.

      (2) Remove tape reproducer, (refer to Section 23-6-1, Removal/Installation).

   C. Remove Tape.

      (1) Remove right side cover of tape reproducer.

      (2) Rewind tape to left reel.

      (3) Remove retainer stud and tape from right reel.

      (4) Remove retainer stud and reel from left reel hub.

   D. Install Tape.

      (1) Mount the replacement reel on the left hub in such a manner that the reel spools off tape from the bottom of the reel, with the dull oxide side up, when rotated in a counterclockwise direction.

      (2) Run off approximately two feet of loose tape and thread on reproducer as indicated by engraved line on panel.

      (3) Remove the tape clip from the right reel.

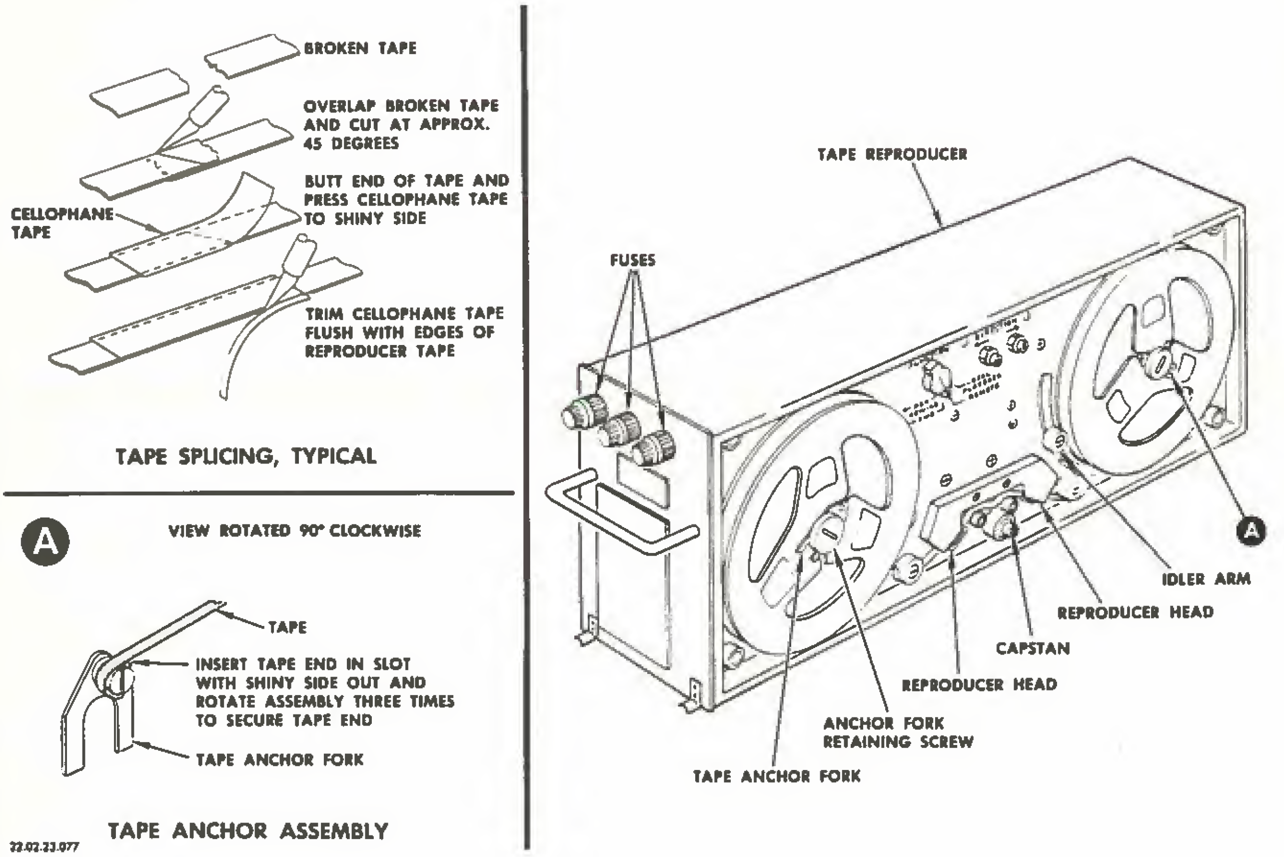
      (4) Insert free end of tape into tape clip pen slot.

      (5) Rotate clip to secure about five turns of tape around pin.

      (6) Insert tape clip into position on right reel.

      (7) Install retainer stud previously removed.

      (8) Take up excess tape left over from threading so that the movable tension arms are positioned to conform with threaded tape position engraved on panel.



Pre-Recorded Tape Installation
Figure 201

(9) Install right side cover of tape reproducer.

(10) Install tape reproducer, (refer to Section 23-6-1, Removal/Installation).

(11) Test operation of tape reproducer system, (refer to Section 23-6-0, Adjustment/Test).

E. Splicing Broken Tape.

(1) Superimpose the broken ends of the tape and trim the ends of the tape at an angle of about 45 degrees. Trim as close to the broken ends of the tape as practicable, to lose as little tape as possible.

(2) Fit the trimmed ends together and apply a short strip of cellophane tape to the shiny side of the recorded tape. Trim the sides of the splicing tape even with the sides of the recorded tape.

PASSENGER CALL SYSTEM - DESCRIPTION AND OPERATION

1. General

Push-pull switches and light assemblies installed near the passengers and in the lavatories enable passengers to call stewardesses. A call by a passenger illuminates a light near the passenger, illuminates lights on forward and aft buffet area panels, and sounds a chime installed in the cabin ceiling near each buffet area. See Figure 1 for schematic diagram of the passenger call system.

When a cabin or lavatory call button is actuated, a light near the passenger illuminates, a light illuminates on each cabin control panel, and both chimes sound in the cabin. The location of the calling passenger is indicated by the light which illuminates on the stewardess' control panels. The chimes will sound again if the passenger again actuates his call switch; but the control panel lights and the passenger's light remain on until the cabin stewardess pulls out the passenger's push-button switch.

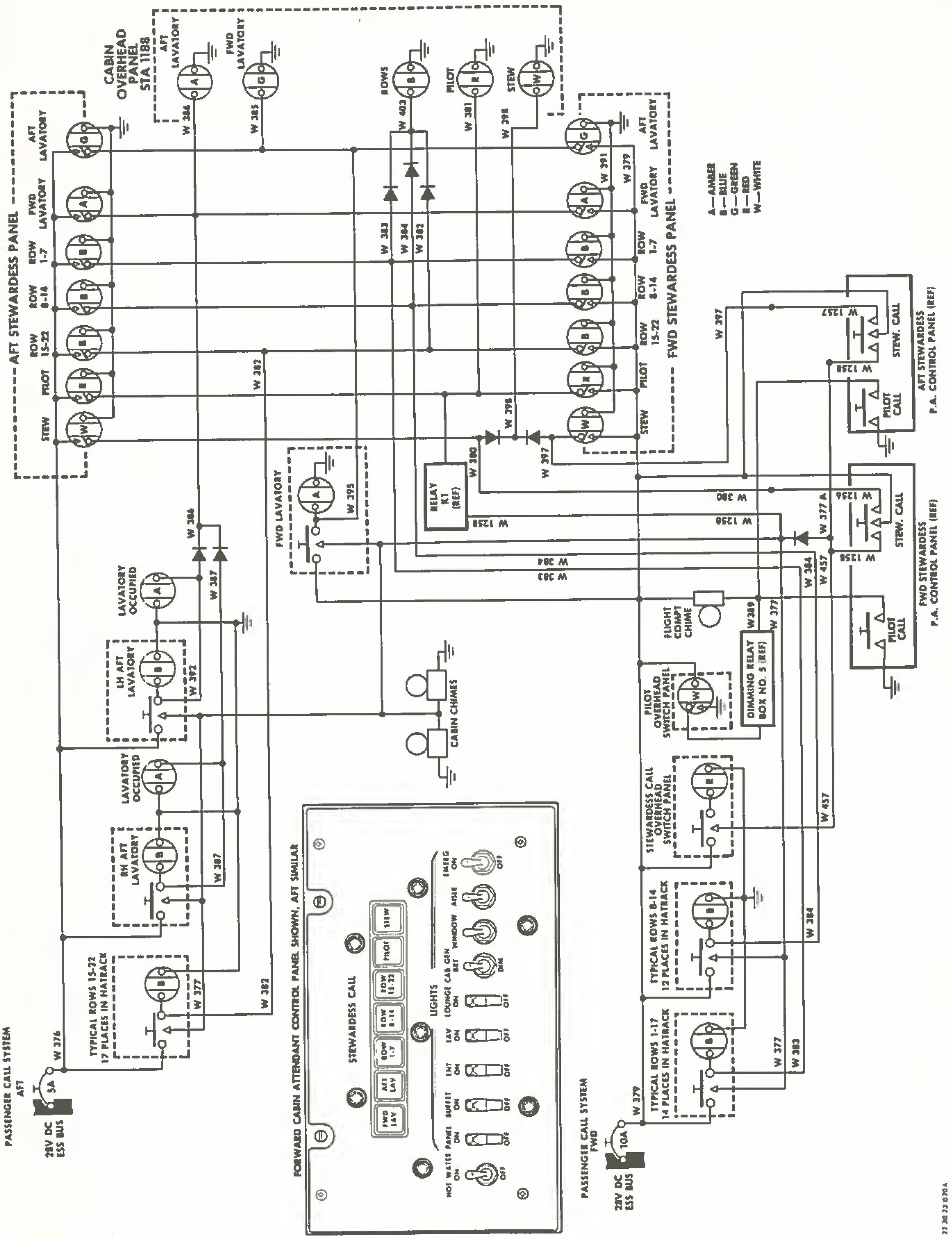
The pilots can call the stewardess by actuating a pushbutton switch on the interior lights switch panel located on the overhead switch panel. This STEW CALL switch sounds the chimes in the cabin, illuminates the PILOT lights on the stewardess switch panels, and illuminates the CALL light on the overhead switch panel beside the call switch.

The stewardesses answer the pilots call by lifting either cabin interphone handset. As the handset is lifted from the hook, hook switches extinguish the CALL light on the pilots' overhead switch panel to indicate that the call is being answered. At the same time the PILOT lights on the cabin passenger call system panels extinguish.

Stewardesses initiate calls to the flight compartment by lifting the interphone handset and pressing the CALL PILOT light switch assembly on the public address control panel. This action illuminates a light on the pilots' public address control panel and sounds the stewardess' call chime in the flight compartment. The call lights extinguish when the pilot lifts his interphone handset to answer the call.

Stewardesses initiate calls to each other from the forward or aft position by lifting the handset and pressing the CALL HOSTESS light switch assembly on the public address control panel. When a call is so made, the cabin chimes sound, and the STEW light illuminates on the panel of the stewardess position being called. This light extinguishes when the called position handset is lifted to answer the call.

Handset hook switches automatically reconnect the handsets into the interphone system when the handsets are replaced on the hooks. This arrangement prevents accidental or unintentional talking over the public address system.



Passenger Call System, Simplified Schematic
Figure 1

To speak into the public address system from one of the three handsets, the operator must actuate a PUSH PA light switch assembly after lifting the handset from the hook.

The forward stewardess' panel is shown in Figure 1. The aft panel is similar but carries passenger reading light switches. Three lights inform stewardesses of the area in which the calling passenger is seated; two lights indicate calls from the forward and aft lavatories; one light signals a call from the flight compartment; and one light signals a call from either stewardess position to the other stewardess. Cabin light control panels are interconnected so that extinguishing a light on one control panel also extinguishes the corresponding light on the other control panel.

Seventy-six lamps are installed in the call systems, including four lamps on the public address control panels. One chime is installed in the flight compartment and two chimes are installed in the passenger cabin.

The passenger call system electrical load is divided between the forward half of the cabin and the aft half of the cabin. A circuit breaker protects each load circuit.

2. Power Requirements

Current drain of the forward passenger call circuit is seven amperes at 28 volts dc. Current drain of the aft passenger call circuit is four amperes at 28 volts dc.

3. Circuit Protection

Power for the passenger call system is distributed from the 28-volt dc essential bus through a 5-ampere aft passenger call circuit breaker and through a 10-ampere forward passenger call circuit breaker. Passenger call system lamp loads are approximately evenly divided between the two circuits. The flight compartment chime and the two cabin chimes are on the 10-ampere load circuit. The circuit breakers are located on the main circuit breaker panel.

PASSENGER CALL SYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. BOTH "STEW" LIGHTS ILLUMINATE WHEN ONE STEWARDESS CALLS THE OTHER	
A. Faulty diode in forward stewardess light panel.	Remove diode from circuit and test forward and back resistance by an ohmmeter. Forward resistance should be high, back resistance low. Replace any diode with low ratio of back to forward resistance.
2. INCORRECT ROW LIGHTS ILLUMINATE WHEN PASSENGER CALL SWITCH IS ACTUATED	
A. Faulty diode or diodes in aft stewardess light panel.	Test diodes as instructed in 1-A above. Replace faulty diodes.
3. CABIN CHIMES DO NOT SOUND WHEN PILOT CALLS STEWARDESS	
A. Faulty diode in call switch assembly in overhead switch panel.	Test diode as instructed above. Replace diode that does not test good.
4. BOTH LAVATORY OCCUPIED SIGNS ILLUMINATE WHEN PASSENGER CALLS FROM EITHER LAVATORY	
A. Faulty diode in aft stewardess light panel.	Test diodes as instructed above. Replace faulty diode.
5. PILOT CALL LIGHTS DO NOT ILLUMINATE ON CABIN LIGHT PANELS WHEN PILOT CALLS	
A. Faulty CALL SELECTOR RELAY in audio junction box.	Press the pilot's call switch on the overhead switch panel in the flight compartment while testing for voltage at terminal No. 2 of the "AF" terminal strip in the audio junction box. If normal 28 volts dc at this terminal, test the continuity of wire W1258B20 from the terminal to connection X2 of the call selector relay in the audio junction box. If the wire is intact, replace the call selector relay.
B. Wiring faulty.	If the fault still persists, test for voltage at junction box terminal No. 3 while actuating the pilot's

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

5. PILOT CALL LIGHTS DO NOT ILLUMINATE ON CABIN LIGHT PANELS WHEN PILOT CALLS (CONT)

	call button. If no voltage at terminal No. 3, test continuity of wire W1253A20 from the terminal to connection D1 of the call selector relay. Repair open wire.
	If 28V dc at terminal No. 3, test continuity of wire W381A18 to the pilot call lights on the stewardess control panels. Repair damaged wires.
C. Faulty hook switch assembly at forward or aft stewardess handset position.	If pilot call light still does not light, make sure that hook switch ground wire W1261B20 finds a ground in the forward stewardess PA control panel through wire TD140B20. This ground is essential to energize the solenoid of the call selector relay in the audio junction box. If ground is normal, check the operation of the hook switch through wires W1262 and W1261. Note that W1261 finds the ground through the aft stewardess hook switch. Replace hook switch assembly if found faulty.

6. PASSENGER CALL SWITCH DOES NOT OPERATE CALL LIGHTS OR CHIMES

A. Switch faulty.	Check that there is voltage at terminal No. 1 of the suspected switch, and that voltage appears at terminals No. 2 and 3 when the switch is actuated. Replace the switch if it does not put voltage on terminals No. 2 and 3.
B. Wiring faulty.	If switch actuation is normal, check continuity of wiring from the switch to the chimes and to the light panels.

7. PILOT CALL LIGHT ILLUMINATES ON STEWARDESS PANELS WHEN PASSENGER CALLS

A. Faulty diode in pilot's call light switch assembly in overhead switch panel.	Use ohmmeter to test the diode for low forward and high back ohmic resistance. If this diode breaks down

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

7. PILOT CALL LIGHT ILLUMINATES ON STEWARDESS PANELS WHEN PASSENGER CALLS (CONT)

	and passes current in the reverse direction, the call selector relay in the audio junction box will be energized. Other obscure abnormalities may also appear in switch, call light, and chime operation when this diode fails to block reverse current.

8. PASSENGER CALL LIGHT DOES NOT ILLUMINATE WHEN SWITCH ACTUATED

A. Lamp burned out.	Unscrew the plastic push-pull button of the light switch assembly and check the lamp in the button. Replace the lamp if burned out.
B. Light switch assembly faulty.	Open the cover in the hatrack and check the operation of the switch by an ohmmeter, without electrical power in the circuits. Replace the switch if faulty.
C. Wiring faulty.	Energize the call system, open the cover in the hatrack, and test for voltage at the switch by a voltmeter. If no voltage, test the wiring from the circuit breaker to the switch. Repair open or short circuits.

PASSENGER CALL SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Passenger Call System

   A. Equipment required.

      (1) External ac power unit.

   B. Preparation.

      (1) Connect the ground power unit and switch on dc power.

      (2) Close PASS CALL SYS - FWD and AFT circuit breakers on the main circuit breaker panel.

   C. Test Passenger Call System.

      (1) Test each call switch and light in the hatracks. Forward and aft chime should sound when a switch is actuated, and lights should illuminate on three stewardess panels. Make sure that panel lights that illuminate correspond correctly to the rows. Chimes should sound each time a call switch is actuated from its detent position, while lights remain illuminated. Pull the switches out from detent position. All call system lights should extinguish.

      (2) Similarly check call system switches and lights in the forward and aft lavatories.

      (3) Close PA AMPL - AC and DC circuit breakers.

      (4) Press the pilot call switches on the stewardesses public address control panels. Right-hand flight compartment chime should sound. Call light should illuminate on the pilot's public address control panel and remain illuminated until the handset is lifted from the hook.

      (5) Press the stewardess call switch on each stewardess public address control panel. Forward and aft cabin chimes should sound. STEW light on the called control panel should illuminate and remain illuminated until the handset is lifted from the hook.

      (6) Press the STEW CALL switch on the INTERIOR LIGHTS panel in the overhead switch panel in the flight compartment. The lamp in the switch assembly should illuminate, the forward and aft chimes should sound in the cabin, and the three STEW call lights should illuminate on the stewardesses panels. Pull out the STEW CALL switch from its detent position. All STEW call lights should extinguish.

      (7) Leave all passenger call lights extinguished and disconnect external power.

PUSH-PULL LIGHT SWITCH - MAINTENANCE PRACTICES

1. Removal/Installation Push-Pull Light Switch (see Figure 201)

   A. Equipment Required - None.

   B. Remove Light Switch Assembly.

      (1) Open PASS CALL SYS - FWD and AFT circuit breakers on main circuit breaker panel. (Hang warning signs on open circuit breakers.

      (2) Open the cover in hatrack for access to switch.

      (3) Disconnect wire terminals from switch. Attach identification tags to wires for installation. Tape wire ends to insulate them from a possible short circuit.

      (4) Remove switch.

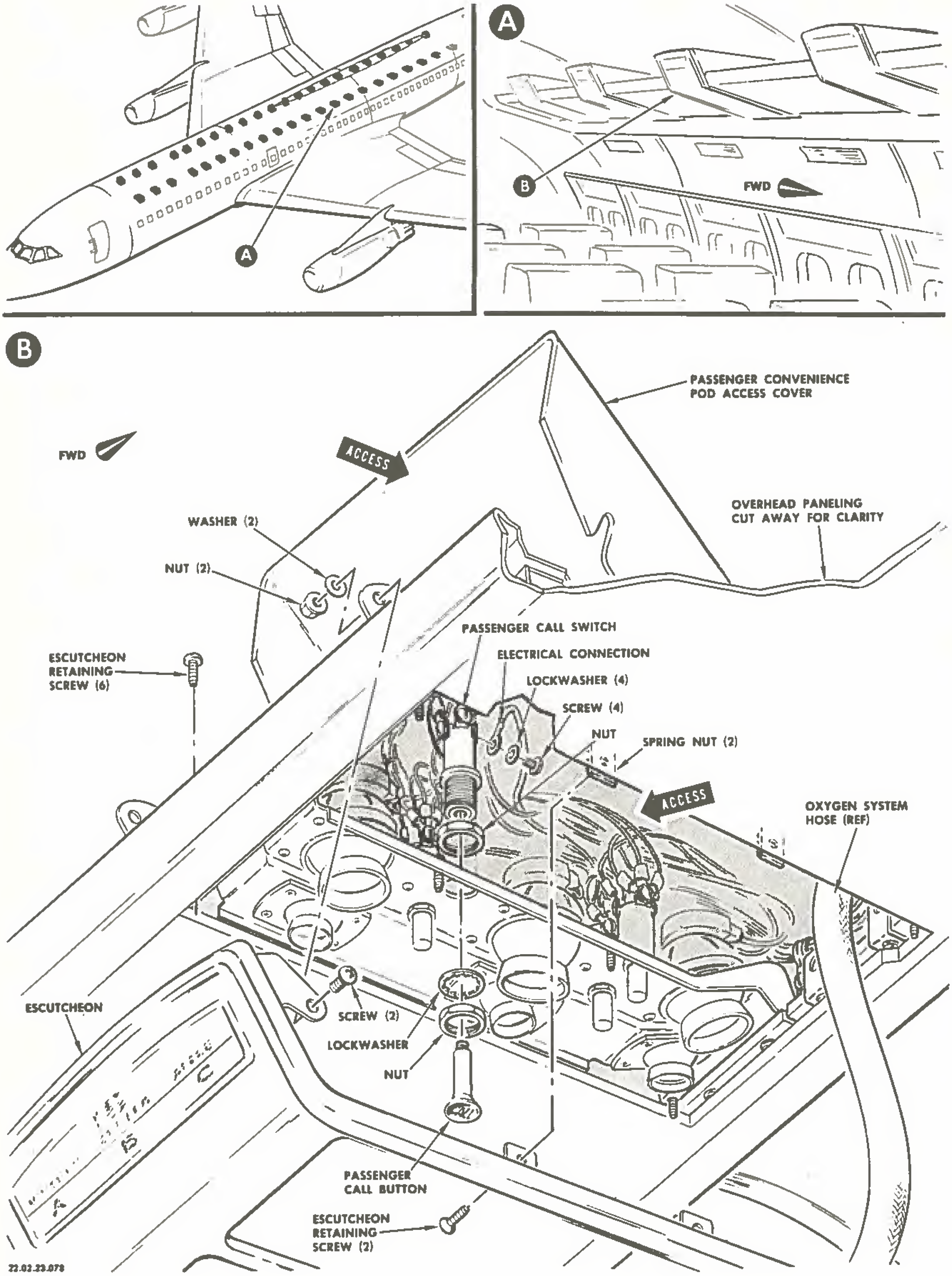
   C. Install Light Switch Assembly.

      (1) Install switch in space provided.

      (2) Connect wires to switch in accordance with identification tags.

      (3) Close PASS CALL SYS - FWD and AFT circuit breakers and remove warning sign.

      (4) Test system operation, (refer to Adjustment/Test).



Passenger Call Switch Installation
Figure 201

PASSENGER CALL LIGHT LAMPS - MAINTENANCE PRACTICES

1. Removal/Installation Passenger Call Light Lamps

   A. Equipment Required - None.

   B. Remove Lamp.

      (1) Unscrew plastic button of light switch.

      (2) Remove faulty lamp.

   C. Install Lamp.

      (1) Place new lamp in plastic switch button and screw plastic button back into switch assembly.

      (2) Test system operation, (refer to Adjustment/Test).

PASSENGER CALL SYSTEM CHIMES - MAINTENANCE PRACTICES

1. Removal/Installation Passenger Call System Chimes (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open PASS CALL SYS AFT and FWD circuit breakers on the main circuit breaker panel. Hang a warning sign on the open circuit breakers.

   C. Remove Chime.

      (1) Remove two dome nuts that sustain the sound bar and remove the sound bar.

      (2) Remove two Phillips-head screws from the opposite ends of the chime and lower the chime for access to the electrical connections.

      (3) Disconnect the wires from the terminals on the end of the chime and attach identification tags for installation. Insulate the wires with plastic tubing or sheet vinyl plastic to prevent short circuit.

   D. Install Chime.

      (1) If chime is assembled, remove the two cap nuts and the sound bar.

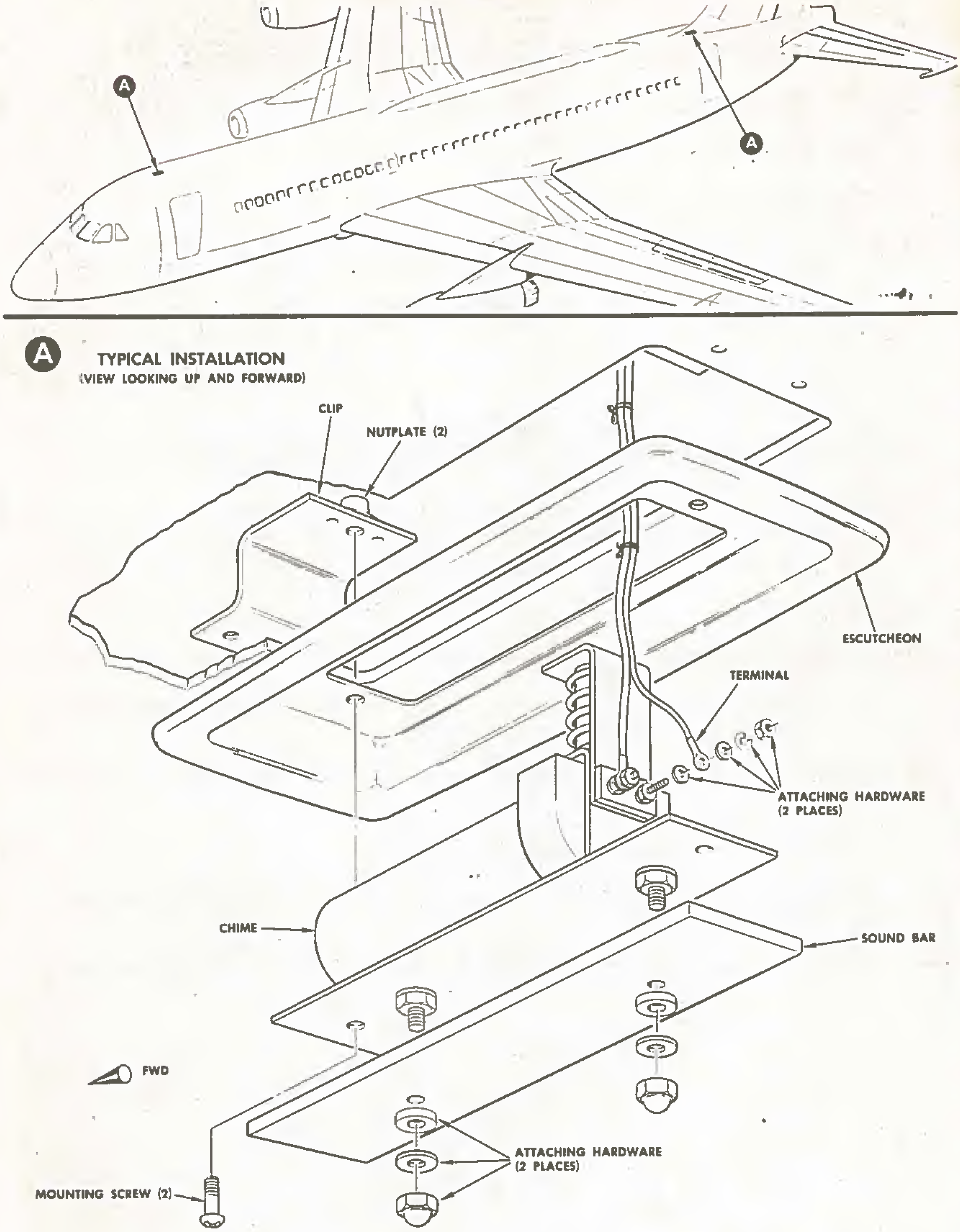
      (2) Connect the electrical wires to the terminals of the chime in accordance with identification tags.

      (3) Position the chime and install two Phillips-head screws to secure it in place.

      (4) Install the sound bar and two dome nuts.

      (5) Close the PASS CALL SYS AFT and FWD circuit breakers and remove warning sign.

      (6) Test system operation, (refer to Section 23-7-0, Adjustment/Test).



Passenger Call Chime Installation, Typical
Figure 201